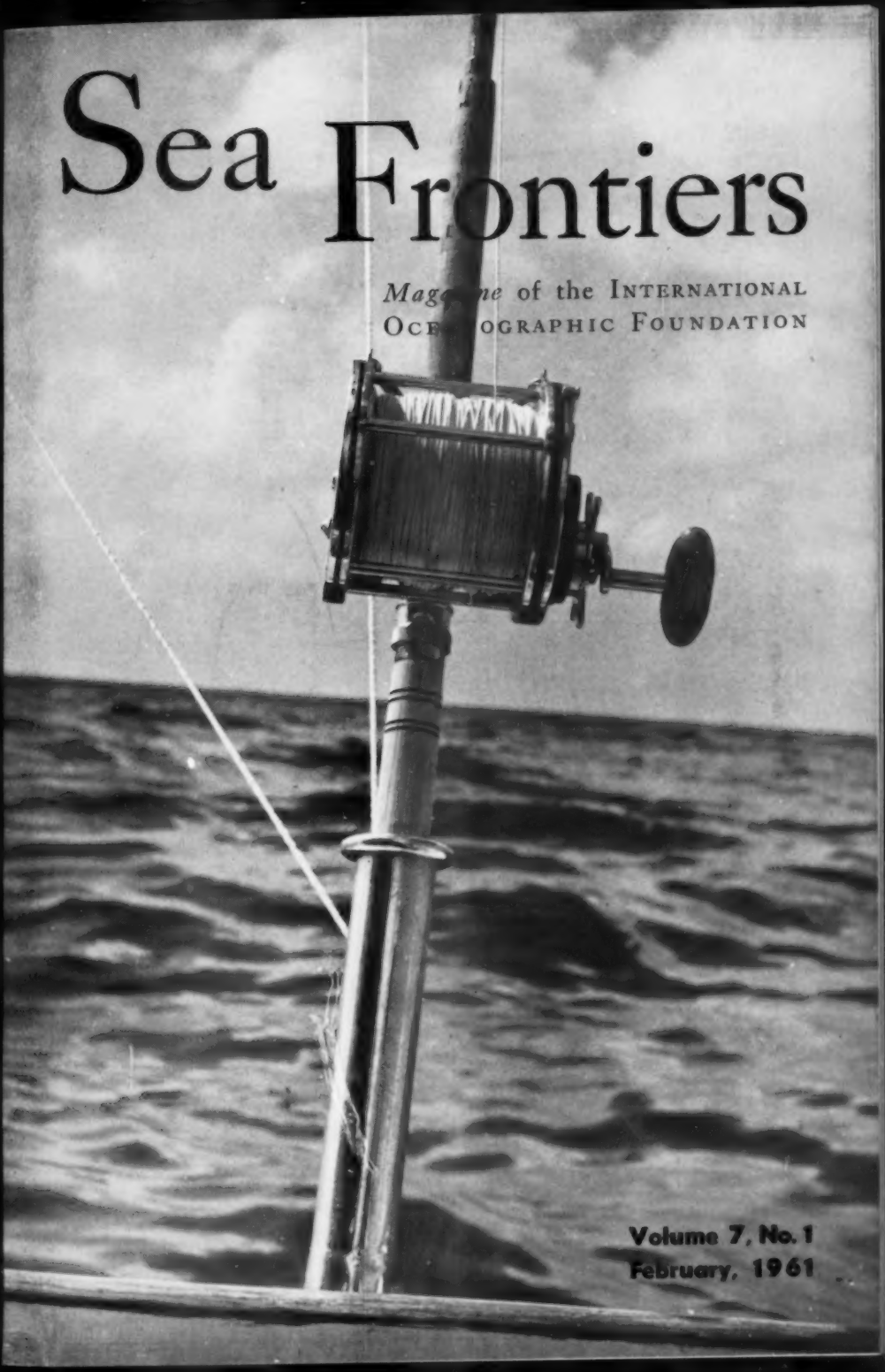
Sea Frontiers

Magazine of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION



Volume 7, No. 1
February, 1961

HERE'S NOT LOOKING AT YOU! *What appear to be evil, calculating eyes are really the nostril openings of a big skate. The real eyes are on the opposite or upper side of its head. (Bernard L. Gordon)*

FRONT COVER. *Symbol of the game fisherman is the rod and reel, here resting in a socket of a charter fishing cruiser off the coast of North Carolina. The line to the left extends to an elevated outrigger, which gives a similated live-movement to the bait in the water. More and more anglers are assisting marine scientists by gathering useful data, such as place, date, and dimensions of their catches. (State of North Carolina Photo)*

BACK COVER. *Barnegat Light, the focus of Barnegat Lighthouse State Park, has stood at the northernmost tip of Long Beach Island for over a century. The Park is a favorite with New Jersey fishermen, picnickers, artists and photographers. (New Jersey Department of Conservation)*

SEA FRONTIERS

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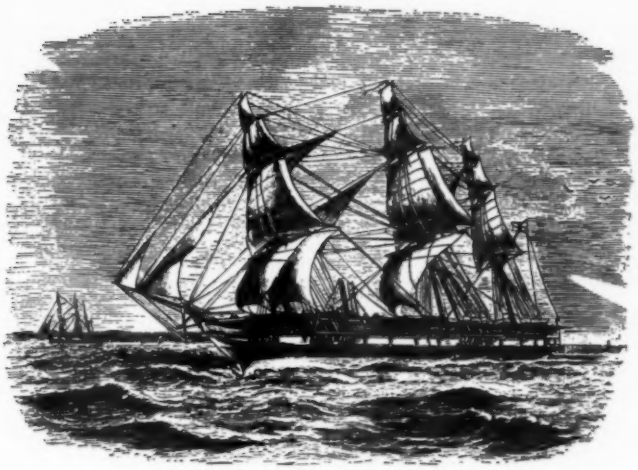
Table of Contents



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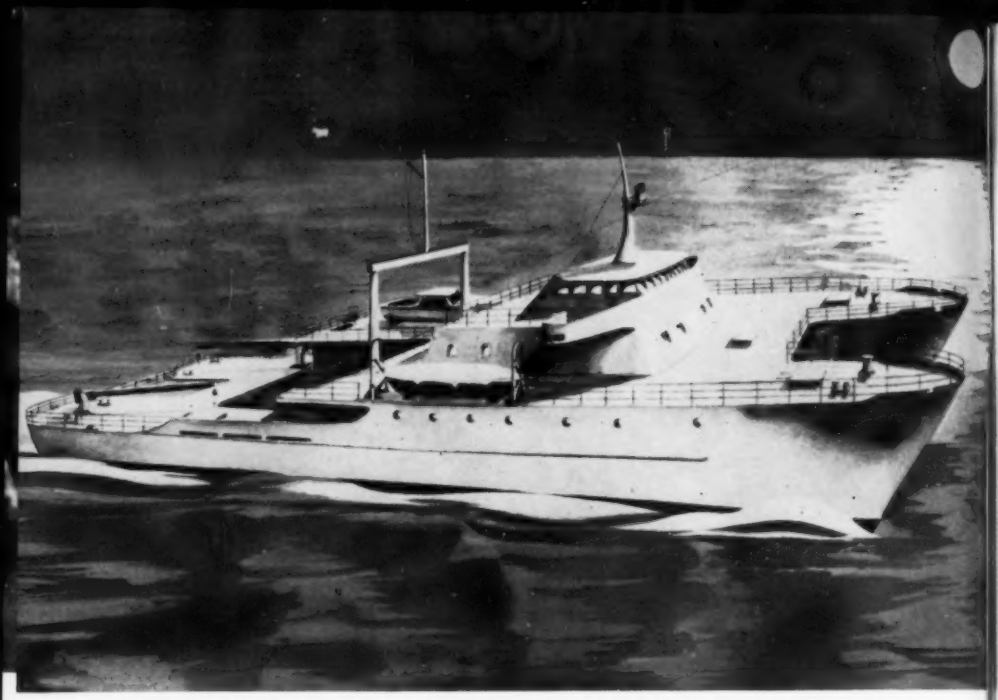


ARTIST'S CONCEPTION *of a catamaran or twin-hulled oceanographic research vessel, designed by Friede and Goldman, Inc., of New Orleans, for The Marine Laboratory of the University of Miami. Feasibility studies call for a ship 140 feet long, with a 53 foot beam, and a 1000 horsepower engine producing a speed of 13 knots. Yet the vessel would draw only 6½ to 9 feet, permitting it to engage in oceanic research among reefs and in other shallow-water areas. (Friede & Goldman, Inc.)*

Catamaran, New Concept in Research Vessels

By F. F. KOCZY
The Marine Laboratory, University of Miami

THE BEST SAILORS in the world are certainly the Polynesians. The art of boat building, which they glorified as a religious cult, and the perfection of their seamanship made it possible for them to reach island after island in the Pacific.

Their ships were of two different types with basically the same twin-hull idea. One, still in use for fishing, diving, and communication between islands in the same archipelago, is the high-speed catamaran. The other, a heavier transport catamaran, was originally intended for emigrants when the population pressure made it necessary for sizeable groups to find a new, unpopulated island.

The big transport catamarans consisted of two canoes connected by a wide platform on which the emigrants, domestic animals, fruits, vegetables and even live fires were transported. This type of vessel found its way into modern boat design for racing sailing vessels and lately also for power racing. High speed was the feature most desired, achieved by the advantageous ratio of length to beam of the hulls which, in its turn, could be attained because two hulls gave the necessary stability and each of the hulls could be reduced to a minimum.

Polynesian "cats" had to be very light, not only to enable them to skim over treacherous reefs but also so that they could be beached by a few persons. Speeds up to sixteen knots have been reported for the lighter, high-speed types. The transport catamaran maintains the same characteristics, but adds another feature, a large transport platform. Happily, the essential features of a catamaran are the three main requirements for an oceanographic research vessel, i.e. stability, high speed, large platform.

"Sea Kindness" Also Needed

Other requirements: (1) "sea kindness" in order to be able to carry out delicate laboratory work on board and allow non-sea-resistant scientists to participate as active members on cruises; (2) reduced roll and pitch, for similar reasons, and for easy navigation; (3) ready access to the water; (4) good protection against weather and breakers, and (5) maneuverability, in order to be able to keep the vessel at a desired position during adverse conditions of currents and waves.

Some Compromises

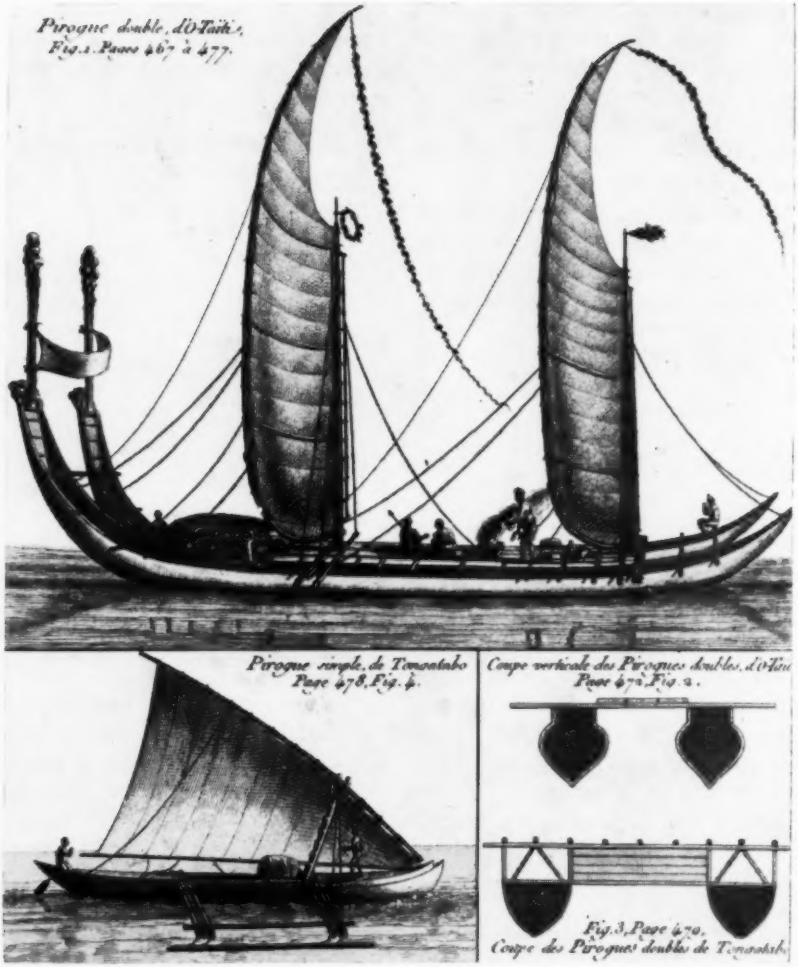
Further requirements are dictated by the special use intended for the ship, i.e., biological research, survey, acoustical work, geophysical research, seismic work, geological investigations of the sea floor, taking water samples for temperature and salinity, or other scientific endeavors in which oceanographers may indulge.

It is impossible, of course, to construct a vessel which is equally good for all the requirements of scientists and some compromises will have to be made, but they should be kept to a minimum. Scientists hope that eventually they will be able to cover the whole range of oceanographic work with only a few types of vessels.

Stress a Serious Problem

Two other important points to consider are the environment in which the vessel is to be used, that is, coastal waters or the open ocean, and the duration of expeditions, which may range from a few days to several months. Finally come the economic factors: price of construction and the cost of operation.

After thorough study of many ship types, it now appears that the catamaran design is the best solution to cover the majority of the above requirements. The most serious structural problem in large catamarans has been the stress to which the wing or platform connecting both hulls is exposed. Reinforcements tend



POLYNESIANS FOR CENTURIES *have used the catamaran or double pirogue for long voyages between islands, carrying whole families and cooking fires. This drawing shows (top) the heavier transport catamaran, and a cross-section (lower right) of two types of catamaran hulls. An ancestor of the catamaran (lower left) employed a single light canoe hull, with an outrigger to keep it balanced. (Courtesy Mariners' Museum, Newport News, Virginia)*

to make the craft heavy, and consequently the hull size must be increased, whereby speed is lost.

Before an attempt was made to study the feasibility of a twin hull construction for an oceanographic research vessel, a literature study of existing and past catamarans was car-

ried out. The surprising disclosure of this study was that two twin-hull ships were used as ferryboats on the English Channel between Dover and Calais during the latter part of the nineteenth century. They were paddle-driven boats, in which the wheels operated between the two hulls instead of on each side of a single hull. These are the only reported large size twin-hull vessels operating for a long period of time. All the other catamarans were a maximum of 100 feet long. Only a few months ago it was learned that the Russians have used this principle on a 600-ton river boat for the transport of passengers.

Superior to Converted Vessels

Preliminary discussions with naval architects convinced us also that a multi-hull vessel would present a better solution of the oceanic research problem than any existing conventional hull especially built for the purpose. It was agreed, too, that a "cat" would be more versatile than any converted ordinary ship now in use in the United States.

Of course, we are well aware of the many difficulties connected with the construction of such a radically new design, and the imaginative thinking which must be employed. No blueprints can be taken from the shelf. Money would be needed from the start. Therefore, the National Sci-

A KING-SIZE CATAMARAN *glides along smooth waters near Miami, its big sails spread to a brisk wind off the Gulf Stream. Note the shark tail on the bowsprit, and the boarding ladder between the big twin hulls. This craft is somewhat larger than the average pleasure catamaran. (Sidney Hartshorne)*

ence Foundation was approached for funds to undertake a feasibility study. When these were granted, Friede & Goldman, Inc., Naval Architects of New Orleans, Louisiana, were asked to draw up plans.

Shallow Draft Important

The completed feasibility study was sent to several marine authorities, naval architects, and oceanographic institutions, in order to receive their opinions and critical reviews. The total picture became more and more convincing, and it is more certain than ever that a multi-hull vessel is the correct solution, not only for oceanographic research vessels, but also for many other ships engaged in specialized work at sea.

The design requirements of a vessel for our purposes were specific and tailored to suit the needs of a working ship for The Marine Laboratory, University of Miami. The prime necessity was shallow draft (seven feet), which would enable us to operate on the little-explored but very rewarding Bahama Banks, and in Florida Bay. The duration of special expeditions to these regions may exceed two weeks. Therefore our boat should have proper accommodations and supplies for a total of thirty-five crew members and scientists.

For the amount of laboratory and deck space these men would need, the vessel should have at least a length of 120 feet, and an overall beam of 60 feet. Naturally a ship this large would be expected to be able to do deep-sea work, too, if the necessary fuel and water could be stored.

Range of 9,000 Miles

Therefore we requested an operational range of 9,000 miles and a continuous sea time of 100 days, but conceded that in this case the draft may be increased. From these basic requirements, Friede & Goldman, Inc., started their calculations and worked out the preliminary design.

Their design was also based on model tests at the Davidson Laboratory, Stevens Institute of Technology, in New York, and they arrived at the features listed on opposite page.

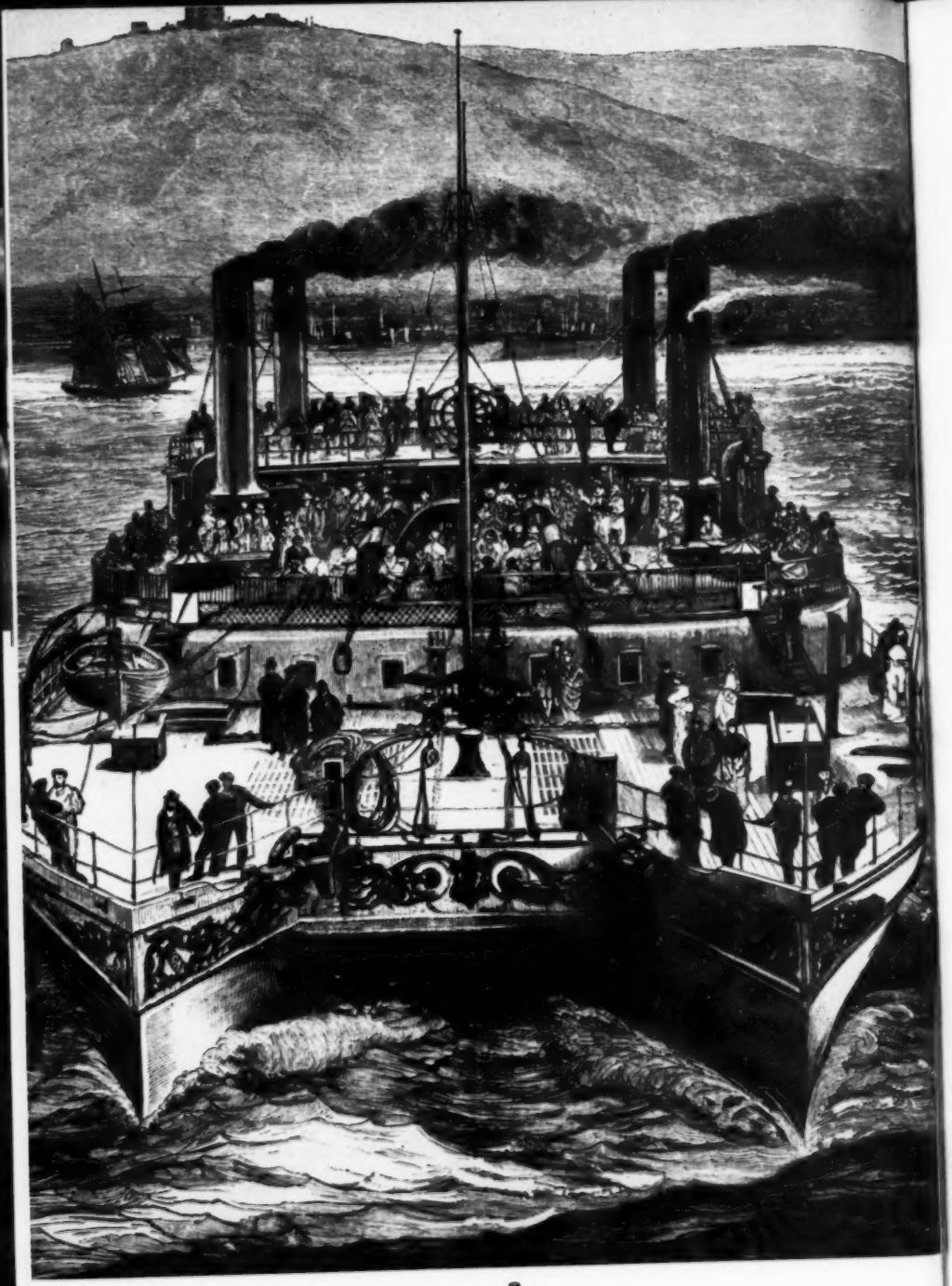
By comparing these statistics with those of a conventional hull vessel, it became obvious that the latter would require an increase of tonnage by fifty per cent in order to obtain the same deck area for scientific use. Moreover, the catamaran, in spite of increased cost per tonnage, would still be twenty-five per cent cheaper than the conventional hull ship. All the required features could be satisfied, it was finally decided, if the length was increased to 141 feet and the beam reduced to 53 feet.

Advantages For Research

Because of characteristic features of twin-hull vessels, new advantages for research are obtained. The centerwell, required for many operations on modern research vessels and difficult to insert in conventional ship bottoms, is automatically given by the catamaran, and much larger and better than on any other vessel. At the stern of the ship a ramp can be constructed between the hulls, allowing

Specifications For Oceanographic Research Catamaran

1. Length overall		141′0″
2. Length, load waterline		130′0″
3. Beam, maximum	(over fenders)	52′7″
Beam, molded, each hull		17′6″
Separation between hulls		17′0″
4. Depth, main deck midship		16′9″
5. Draft, design		8′0″
fully loaded		9′0″
light		6′6″
6. Freeboard, at design draft, forward		17′9″
midship		16′6″
aft		8′9″
6(a) Centerbody clearance at design draft		
midship		8′9″
aft		7′0″
7. Displacement:	light	495
	design	640
	fully loaded	760
8. Gross register tons		Over 300
9. Trial speed (knots)		13.5
10. Service speed at design displacement (knots)		13.1
	fully loaded (knots)	12.6
11. Endurance at 12 knots,	design load	5,000 sea miles
	fully loaded	9,000 sea miles
12. Endurance (days, supplies)	design	60
	fully loaded	90
13. Shaft horsepower (nominal)		950
14. Accommodations:	scientists	15
	crew	18
	total	33
15. Deck areas — laboratories, sq. ft.		
	main deck	1160
	below main deck	120
total area, laboratories		1280
16. Scientific storage areas		650
17. Open deck area for scientific use, sq. ft.		
	above main deck aft	1600
	main deck aft	2400
	upper deck forward	200



the launching of nets and boats, and their easy recovery. Large sized marine specimens can be readily handled there and brought on board.

Vessel Turns in Own Length

Designers claim that the roll of a large "cat" will not exceed nine degrees in the most adverse sea conditions and the pitch should not be more than seven degrees. The speed is calculated to be 13 knots with a 1000 horsepower propulsion. Because of the large deck area the laboratories can be centrally arranged, which facilitates work. Maneuverability is excellent because of the large distance between the propellers. It should be possible to turn the vessel in her own length.

The centerwell can be converted into a high sea pen for specimens of fish and other live animals.

Still Some Who Doubt

While the feasibility study promises a successful craft, there are still some doubts in the minds of suspicious scientists that can only be removed by the building and operation of a full size vessel.

During our work with the study, we learned that a Canadian corporation, Steltner Development and Manufacturing Company, Ltd., has already constructed four twin-hull vessels of smaller design (maximum 60 x 40) for offshore drilling and research purposes. According to reports, they seem to be a full success and their resistance to rough weather conditions is remarkable. The number of days on which it is possible to work has been increased by a factor of two, and navigation without strain was achieved in winds up to 50 knots.

It is encouraging that many other oceanographic institutions have not only shown a lively interest, but have also started to study the possibility of their own use of twin-hull oceanographic research vessels. We believe that the multi-hull ship can be the oceanographic research vessel of the future, but, of course, we still have to prove it. We hope that very soon we shall be able to demonstrate that our belief is a reality.

Small Research Cat Ready Now

Meanwhile, a smaller type catamaran, between forty and eighty feet, will certain become the logical vessel for inshore and estuarian research work. The Marine Laboratory of the University of Miami has a ship of 36 feet length under construction, and hopes to have this prototype in operation about the time this article appears. Woods Hole Oceanographic Institution and the Chesapeake Bay Institute are also planning boats about this size for specialized marine activities.

TWIN STEAMSHIP Castalia *leaves Dover, England, for a speedy crossing of the English Channel to Calais, France. Launched in June 1874, this catamaran type ferry made the cross-channel run for ten years. Fastest trip was one hour and fifty minutes. It was propelled by twin paddlewheels between the 290-feet-long hulls. (Mariners' Museum, Newport News, Virginia)*


BRAIN AREA
ROSE AREA

Underseas Park Dedicated

AMERICA'S MOST unusual preserve and the world's first completely underseas park was formally dedicated on December 10, 1960, at Tavernier, in the Florida keys. Ross Leffler, assistant secretary of the U.S. Department of Interior, acting in behalf of President Eisenhower, turned over the Federal portion of this unique domain to the Florida State Board of Parks and Historical Memorials.

Florida's Governor Leroy Collins, in accepting the part of the park that lies beyond the three-mile limit, announced that its name had been changed from Key Largo Coral Reef Preserve to the Pennekamp Coral Reef Preserve, as a "living monument" to John Pennekamp, associate editor of the *Miami Herald,* who played a vital role in the creation of the new park.

This joint Federal-state action, unusual in itself, set aside about seventy-five square miles of coral reefs and shallow sea bottom as the nation's first marine wildlife refuge. It is an irregular offshore tract, roughly twenty-one miles long and four miles wide, which parallels Key Largo, about midway between Miami and Key West. Its reefs, the finest within the continental limits of the United States, have been the concern of scientists and conservationists for more than a decade because of depredations by souvenir vendors and over-fishing by skin divers. ("First Underseas Park," *Sea Frontiers,* May, 1960.)

In setting up this new park, however, it was not the intention of either Federal or state authorities that it should be simply a conservation area. Plans are well under way to make it accessible to the general public who may wish to observe its colorful underseas life from glass-bottom boats, or through skindiving goggles. Fishing (except spear fishing), underwater photography, skindiving and treasure hunting are other recreational opportunities, although state permission must be obtained before any treasure or historic objects can be removed from the preserve.

Maximum usefulness of the new park cannot be attained, state officials realize, without some kind of a small shore establishment, because the average visitor cannot afford to pay the rates which charter boats must ask to take people out to the reefs. Accordingly the state is proceeding with plans to acquire a tract on Key Largo, north of Tavernier. Here a museum will be erected and parking provided for visitors' cars. A pier and dredged channel will allow fair-sized glass-bottom boats to take groups on viewing trips twice a day for a nominal fee.

YOUTHFUL VISITOR *to the dedication ceremonies for the Pennekamp Coral Reef Preserve admires a temporary exhibit of some of the wonders to be seen beneath the sea. The State of Florida plans to erect a small museum and parking area. (E. John Long)*

HEADS UP! *Out of the sea and into an exhibit tank goes a* Mola mola, *revealing the membranes which strain its food, chiefly small crustaceans, jellyfish, larvae of other fishes and some algae. In the adult, the eye is a little larger than a teacup. (Miami Seaquarium)*

The Fish That Is All Head

By M. D. BELLOMY

OF ALL THE FISHES in the seas, the headfish or oceanic sunfish *(Mola mola)* is certainly one of the most curious. It resembles a big liver-colored bag, loves the sun, has bones so soft that they can be cut with a knife, and is one of the few animals in the world (the loggerhead turtle is another) with an appetite for huge jellyfish, complete with stingers.

There are almost as many common names for this creature as localities in which it has been found. Nearly a hundred years ago, Arthur Mangin's *Mysteries of the Ocean,* in dis-

cussing phosphorescence, offers a plausible reason for the creature being called a "sun or moon" fish:

"Besides the causes of oceanic phosphorescence enumerated, it is needful to point out that certain oval and circular patches, from six to fourteen feet in diameter, with distinct outlines which, in some localities, are often seen to beam with a pale but steadfast light, are due to the presence of the so called sun- or moonfish. This curious member of the great piscine family derives its name from its resemblance to a reflection of either the great luminaries of day or night, though neither may be visible in the heavens."

Does not Revolve like Wheel

This 1868 report continues: "The sunfish is of a circular form, with a broad compressed body, and revolves like a wheel."

To early observers the strange fish probably did appear to "revolve like a wheel." At first glance it truly looks like one. It is large and comparatively round, and has a completely unorthodox style of swimming, but it does not turn round and round. It swings its enormous dorsal and anal fins back and forth at the same time they are being undulated, thus propelling itself slowly, languidly through the water.

In Latin American countries, this fish is still popularly known as the rueda or moonfish. In 1956, a gigantic specimen, weighing 2,640 pounds, was stranded at low tide on the beach near Commodore Rivadavia, Territory of Chubut, Argentina (See "Queer Fish", *Sea Frontiers,* November, 1956, Vol. 2, No. 3).

True Giants of the Sea

Mature headfish are true animal giants. They frequently attain weights of over a ton, grow to be eleven feet long. A specimen mounted in the American Museum of Natural History, New York City, is nearly ten feet long and eleven feet high. When caught it weighed over 2,000 pounds.

This is a huge fish, to be sure, but it is not the largest on record. An Australian specimen, reported by David G. Stead, was captured through an odd accident. The incident is described by Dr. Leonard P. Schultz in *The Ways of Fishes*:

"On September 18, 1908, a little after 1:00 p.m., the *S. S. Fiona,* off the coast of New South Wales about forty miles from Sydney, suddenly shook from stem to stern and her port engine stopped dead. A boat was lowered, and the captain and the crew saw, jammed into the port propeller, an organic mass resembling an elephant in both bulk and skin texture.

Ship Limps into Port

"It was impossible to dislodge the creature, so the *Fiona* limped into port with only one propeller, and her impediment perforce went along. While a crowd stood by gazing and gaping, a huge iron hook, especially forged for the purpose, was lowered into the water and used to dislodge the enmeshed fish.

"Here a sailor's poison was ichthyologist's meat, for had it been possible to remove the fish at sea, the largest ocean sunfish on record

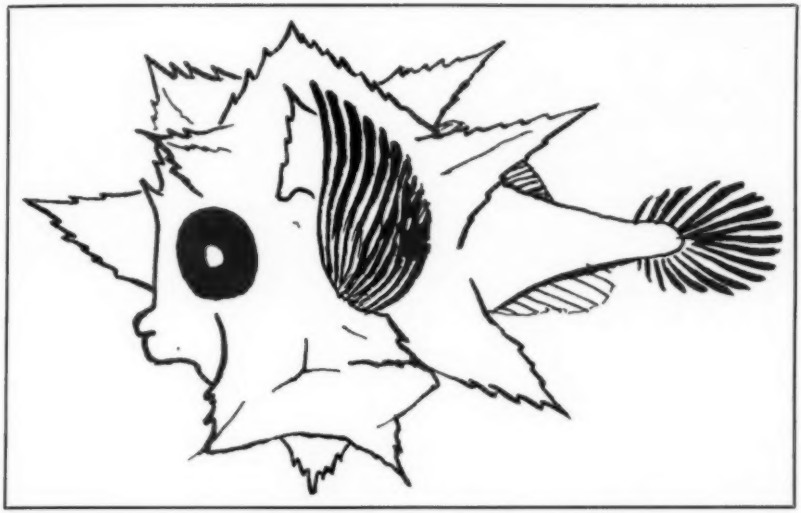
would never have been weighed and measured. It was two and a half feet thick, ten feet two inches long, thirteen feet four inches from the tip of its dorsal fin to the tip of its anal, and, perhaps, most startling, weighed 4,400 pounds—over two tons!"

Rarely Captured Alive

Although adult sunfish have rarely been captured alive, visitors to the Miami Seaquarium have had several opportunities to see them at close range. In 1958, a 400-pound specimen was caught by sports fishermen in the Gulf Stream off the Florida coast. It was towed to shore and hoisted into the Seaquarium's huge 80-foot main tank.

At first, the great fish refused to eat, so for two days, divers forcibly fed it. Then, the peaceful giant became accustomed to its new home and began eating regularly. However,

MEMORIAL TO A COUSIN *of the* Mola mola. *In February 1958 a rare oceanic animal washed up on the beach of the University of Miami Marine Laboratory, where it was identified as the sharp-tailed sunfish* (Masturus lanceolatus). *It was transferred to the main tank of the Miami Seaquarium nearby and lived for several days. Later this reproduction of it became a permanent exhibit in the garden of the nearby Seaquarium. Captain William B. Gray, director of collections and exhibits, points out a salient feature of the strange fish to Mr. Fred D. Coppock, former president of the Miami Seaquarium. (Miami Seaquarium)*



YOUNG LARVAE *of the* Mola mola *are so unlike the adult that they are often mistaken for a different species. Shortly after hatching the caudal fin disappears and a formidable armor of strong spines is acquired. The spines, projecting in all directions, serve as a kind of protective sheath during helpless infancy. (after Schmidt, magnified ten times)*

on the fifth day, saddened attendants watched as their big pet grew weaker and weaker. It finally died, apparently from injuries sustained during its capture.

Sharp-Tailed Sunfish

A few days later, one of *Mola mola's* little known cousins, the pointed or sharp-tailed sunfish *(Masturus lanceolatus),* drifted up to the pier of The Marine Laboratory, University of Miami, not far from the Seaquarium. With the aid of scientists from the Laboratory, who leaped into a small boat and seized its long dorsal fin, the 500-pound creature was captured and transferred to the Seaquarium's big tank. This rare sunfish, like the others, lived only a brief period in captivity, and then died. Its body was recast in plastic, and can be seen in the Seaquarium grounds.

In March, 1960, another *Mola mola* paid a visit to the Miami area. While it was swimming sluggishly in the shallow water off Crandon Beach, lifeguards spotted it, and notified the Seaquarium, which sent its special specimen-collecting boat. This 600-pound sunfish was carefully transferred to the main exhibition tank, but it, too, died a few days later.

Order of "Joined Jaws"

In company with eight or nine other families, including the puffers, porcupine fishes, bonefishes, triggers and filefishes, the head or sunfish

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completes the order *Plectognathi* (meaning "joined jaws"). Although the creature's mouth is quite small, it is studded with a rather remarkable set of "teeth." They are joined to form a single plate above and below, sharp at the edges with a broad crushing surface inside.

This kind of beak-like dentition is found in fishes feeding mainly on hard corals and molluscs. The *Mola mola* eats small molluscs when they are obtainable, but its usual diet consists of small fish, and jellyfishes of all sizes, with or without stingers.

Dr. MacGinitie, director of the Kirkhoff Marine Laboratory in California, witnessed the feeding of a headfish on large jellyfish. The headfish circled slowly around the jellyfish, eating away at the margins until it was consumed. Often the jellyfish would be pushed to the surface, when weird gustatory sounds would be heard as the *Mola mola* bit off large pieces. Dr. MacGinitie believes that tremendous numbers of jellyfish must be eaten, because they are about 96 per cent water.

Does It Have a Voice?

Would it be going too far afield to say that the *Mola mola* has a voice? Scientists admit it makes sounds—harsh grating noises—such as might result when one brick is rubbed against another. This is done by grinding the upper and lower teeth together. Its eyes are as big and round as teacups, but the creature has only a peanut-sized brain which may be why some observers consider the headfish a singularly stupid animal. Unlike most fishes, the species lacks an air or swim-bladder, the mechanism with which most aquatic animals maintain a certain position or balance in varying depths of water.

Baby or larval headfish are even more extraordinary in appearance than their odd, sun-loving parents. Almost immediately after birth, they lose their minute tail fins, and acquire a formidable armor of spines projecting in all directions from their small bodies. The spines offer a measure of protection for them during a period of extreme helplessness, and may also act as flotation processors.

Develop Into "Horns"

Five of the infantile spines later develop into long "horns." One grows upward from the middle of the back, a second from the snout or "nose," a third from the chest, and the fourth and fifth, from opposite sides of the body.

A little later the shape of this remarkable fish undergoes another astonishing change. It becomes deeper or wider than it is long, the elongated spines shorten into abbreviated back and tail fins, which are connected by a newly-formed miniature tail.

When these alterations are complete, the youngster is about half an inch long. From this time on, it will gradually take on the form of the adult headfish.

HEAD ON, *the big fish presents an almost human appearance.* Mola mola, *eyes closed, seems to be enjoying the attentions of the diver who has just fed him some squid. (Miami Seaquarium)*

The headfish has scant value to mankind except as a curiosity and as an involuntary collector of smaller, sometimes rare, specimens of deep-sea life. Its flesh is leathery and generally considered inedible, except by the Japanese, who relish its liver.

Although a peace-loving individual, this docile sun-worshipper has its share of enemies. Killer whales will attack a solitary animal, literally shredding its tough skin and devouring the soft inner parts of the carcass. Sharks, too, occasionally dine on smaller specimens.

Sports fishermen sometimes try for the headfish because of its great size, and for the sensation they create if they are successful in bringing one in to the dock, or even near the shore where aquarium specimen-boats can take over.

Actually, there is no sport whatsoever in hooking these huge animals. They have no defense, offer no resistance. Moreover, they move so slowly that harpooning them is about as sensational as spearing a floating log.

Troubled Oil on Water

Anyone who has ever stepped in tar on the beach, and tried to get it off his feet, working on it at home hours later with turpentine and a rag, may be relieved to know that the problem is international, and that there is an organization trying to do something about it. Bathers all over the world, it appears, stumble into the same obnoxious blobs, and have the same removal problems.

What is the source of this black nuisance? Chiefly tankers. Millions of tons of oil-contaminated water are being dumped into the ocean every year by such ships when they clean out their tanks. This oily sludge does not dissolve or sink. It floats on the surface, and most of it almost certainly will be deposited on some coast.

The problem is worst on the beaches of Great Britain and the continent of Europe. A British Government committee of inquiry reports, "Many beaches have been frequently and heavily polluted and the nuisance has become intolerable." In mid-ocean thousands of seabirds have been killed by the film of oil on the water.

An international conference of forty-two nations, representing 95 per cent of the world's shipping tonage, has been organized by the British Co-ordinating Advisory Committee on Oil Pollution of the Sea. The aim of this group is, first, to prohibit the discharge of oil in certain agreed zones, and, finally, to prohibit completely oil discharge anywhere at sea.

The London Conference wants to require also that all ships using heavy oil have devices to prevent it from escaping into the bilge, that tanks or lighters should be provided for dumping oil waste in the main ports, and that ships which use their fuel tanks for water ballast should install machinery that will separate oil and water before the water waste is pumped overboard, so that the oil residue can be disposed of in port.

COMING ABOARD *in the approved fashion. This is the older, or Mark VI model, in which the divers sit back-to-back. Four control valves enable the MiniSub to perform any maneuver an airplane can manage, such as climb, dive, roll, and turn. Fins are swept back to allow shedding of seaweed and debris. (Aerojet-General Corporation)*

For Hitch-Hiking Scuba Divers

By GARDNER SOULE

WHAT THE automobile is to the pedestrian in quest of a lift, the MiniSub is intended to be to the Scuba (Self Contained Underwater Breathing Apparatus) diver. That is, the tiny, free-flooded (not airtight) submarine is a vehicle designed to save the muscles and strength of the underseas explorer.

This smallest of submarines is intended, its manufacturers (Aerojet-General Corporation, Azusa, California) say, for "highly-efficient underwater travel, and for spear fishing, salvage, surveys, scientific studies, and search."

Already in Use

The MiniSub can be equipped with a searchlight, and one model has been sold with a built-in spear for shark

hunting. The MiniSub is already being used by the U. S. Navy for underwater demolition teams, by the Greek Navy, and commercially for taking movies, and inspecting undersea pipelines and cables.

Within a MiniSub, its makers figure, two divers can cover six miles of undersea territory in an hour and a half beneath the surface. That is, if they propel the MiniSub themselves by turning its two aluminum propellers with foot pedals. But the de luxe model of the MiniSub has a one-horse-power electric motor and battery. In this one, the two men, not pedalling at all, could explore eleven miles of sea terrain in a two-hours' dive.

Compared With Fins

A swimmer with fins, for comparison, can search only about a mile and a half in an hour and a half of submerged prowling. Top speed of an expert finned Scuba diver is about 1.75 miles per hour. Speeds of the MiniSub are 1.7 miles per hour when pedalled by one man; 2.6 miles per hour when two divers are at the ped

IN THE MARK VII MODEL, *two divers lie side-by-side, one handling the control wheel and the other attending to navigation, electronic or photographic equipment. When equipped with battery and motor, this newest MiniSub can travel up to 5.7 miles per hour. Eleven miles of underwater territory can be explored in a two-hour's dive. (Aerojet-General Corporation)*

als; and up to 5.7 miles per hour when battery and motor are doing the work.

The battery used in the electrically-driven model consists of two standard 12-volt automotive batteries of high-ampere hour capacity, housed in a heavy-wall fiberglass waterproof tank.

The Mark VII MiniSub is 13 feet, 10 inches long. The foot driven model weighs 525 pounds; the battery-operated, 975 pounds. Both models are slightly buoyant. In either, the two divers lie side-by-side on their stomachs.

Climbs, Dives, Rolls and Turns

The Mark VI is an older model, 14 feet, 4 inches long. In it, the divers sit back-to-back. The four control valves or fins let the MiniSub perform any flight maneuver an airplane can manage (climb, dive, roll, and turn). Fins are swept-back to allow shedding of seaweed and debris.

In the latest Mark VII model, the control wheel is in front of the left-hand operator, leaving the man on the right free to attend to navigation, electronic or photographic equipment. A compass and depth gauge are standard equipment, to which may be added temperature and salinity recording devices for exploration of the little known layers and water zones which present intriguing problems to present and future marine scientists.

Any Depth Scuba Divers Can Reach

The MiniSub can carry as much as 340 cubic feet atmospheric reserve breathing air. Or snorkel breathing tubes may be used when it is operated near the surface. In any case, the time the MiniSub can remain submerged is limited only by the divers' breathing apparatus. The boat will function at any depth Scuba divers can reach.

The hull and control fins are of polyester-bonded glass cloth in various thicknesses. Entrance to or exit from the MiniSub is by large hatches fitted with quick-release mechanisms, for escape in the event of an emergency. The ballast tank may be flooded to park the craft on the sea bottom. The sub may be raised with surplus breathing air.

Southward Go Japanese Fishermen

Japan, the leading fishing nation in the world, now is exploiting the rich seas around Australia and New Zealand. Most of the newly-arrived Japanese vessels fish for tuna, but some also trawl for snapper. Opening of a fish-canning factory in American Samoa gave impetus to this southward movement.

Fisheries experts have long known that New Zealand waters are exceptionally bountiful in food fishes, but little effort has been made locally to develop the industry, partly because New Zealanders are light fish eaters, but chiefly because the low cost structure and far-flung operations of the Japanese would always enable them to undersell New Zealanders in the Asian market.

MENHADEN MOTHER SHIP Mermentau *puts out for the fishing banks, its lookouts keeping a sharp watch for copper-colored areas, indicating schools of fish. Purse boats are swung in their davits, ready for instant action. (N. Kenneth Ebbs)*

From One Dilemma to Another

By C. P. IDYLL
The Marine Laboratory, University of Miami

PERU HAS SOLVED one perplexing dilemma and then, suddenly, has plunged herself into another. Unfortunately she has carried most of the fishing nations of the world with her into the second problem.

In a previous *Sea Frontiers* (August, 1960) the issue facing Peru, an apparent conflict between the ancient guano industry and the brand new fish meal industry, was described in an article entitled "Birds or Fish? — Peru's Dilemma."

The problem arose because the production of guano (bird dung of great value as fertilizer) and fish meal utilize the same raw material, the immense anchoveta fish stocks of the Pacific Ocean off the coast of Peru. The Peruvians were confronted with the question: Would the catching of large quantities of anchovetas by boats supplying fish meal factories be taking the food from the mouths of the birds so that the production of guano would be seriously affected,

and, if so, would the new fish meal industry be a worthwhile substitute for the guano industry?

In the late 1950's the government of Peru had not made up its mind as to which of these alternatives was best.

Two Answers Possible

The *Sea Frontiers* article, on the basis of an examination of the comparative amounts of fish used by the birds and the fishermen, and the values of the products derived from each, came to the conclusion that it seemed likely that the best economic use of the anchoveta resource would be to allow the fishermen to catch them for the production of fish meal. However, it also appeared, from the history of other fish stocks and the probable rate of exploitation by the fishermen in the foreseeable future, that it need not be a matter of "either/or," but that the birds *and* the fishermen could take as much fish as they needed.

In the meantime the Peruvian Government likewise came to this conclusion and decided that it need not be "Birds *or* Fish" but "Birds *and* Fish." This is not the final word, since the research has not been done which will decide conclusively how much fishing can be done by birds and man combined. But for the present Peru is committed to strong support for the fishing industry, and this has resulted in dramatic expansion of the fleets and of fish meal plants. The country is thus plunged headlong into the second dilemma, which is nothing less than a derangement of the world market for fish meal.

Delicate Balances of Trade

For most commodities in the market places of the world there is a delicate balance between demand and supply, with production being adjust-

TWO MENHADEN PURSE BOATS *from the* Fish Hawk *closing a big purse seine after surrounding a school of fish. The net is being pulled in by power blocks. In the background a large tanker passes. (N. Kenneth Ebbs)*

ed to the capacity of consumers. Of course, when the raw product, such as fish, has a variable level of supply, the vagaries of which are compounded with those of the weather to produce periods of shortage or of glut as often as periods of steady supply, this close following of supply behind demand is sometimes altered.

Nonetheless, fishing effort and manufacturing levels can be adjusted even in fisheries operations, and the supplies of fish meal have been closely dependant on the market for this product. Hence, when greatly increased quantities of fish meal suddenly poured into the market places of the world as a result of Peru's strong entrance into the picture, the result was disastrous for those engaged in the industry.

The rise of the Peruvian fishery for anchovetas has been astonishing. Although the huge stocks have existed in the rich waters of the Humboldt Current ever since man inhabited Peru, it was not until ten years ago that they were fished on any sizeable scale. The first fish meal plant was built in 1950, and for the next half decade the industry struggled to emerge, its growth hampered by official doubts as to the wisdom of competing with the guano birds. By 1955 only 22,000 tons of fish meal were produced in Peru compared to a world production of 1,372,000 tons.

The pace of production began to

PURSE BOATS CLOSE IN *on the mother ship, the purse seine vessel* Fish Hawk. *The net is being "dried up" so that fish can be pumped aboard. On the gunnel of the purse boat (left) rests a power block used to haul in the net, thus reducing fishermen labor. On the right is a pump whereby fish are pumped out of the net into the fish holds.*

quicken at this point, and in the next two years Peru manufactured 34,000 tons and 71,000 tons respectively. In the latter year, 1957, Peru was still only twenty-sixth among the fishing nations of the world. When the government made its decision to unbar the door to fishermen, Peru began to make itself felt in the world's fish markets. Production nearly doubled in 1958, and again in 1959, so that in the latter year the amount of fish meal manufactured was about 300,000 tons, and Peru had risen to fifth place among the world's fishing nations.

Thus Peru had added fish meal to the world's markets in the amount of about a quarter of the former total. The balance between supply and demand could not stand this increase. The market reacted by a headlong plunge. From a price of $140 per ton in 1959, it fell rapidly to disastrous levels, and stands between $65 and $95 per ton at present. Production costs vary greatly, depending on the efficiency of the operation, but few, if any, of the plants in the United States, regardless of their efficiency, can produce meal at much less than $87 to $90 per ton, and plants in other countries, including Peru, are unable to do much better.

Casualties in Many Places

Many nations are affected by this unhappy situation. Germany is casting around desperately for a solution; the Norwegian herring reduction industry is badly hurt; Canada suffered a prolonged period of shut-down of its meal industry when the gap between cost and selling price produced a dispute between herring fishermen and plant owners; Iceland, Japan, South Africa and Angola have all turned alarmed eyes to the coast of Peru.

And, of course, Peru did not escape the consequences of its own activities; the abrupt fall of fish meal prices has proved calamitous to the infant industry there. Large investments in ships and plants had been made with the expectation of paying them off with $140 a ton fish meal; many companies have not been able to weather the storm with $90 a ton fish meal.

The troubles that Peru has brought down upon the world's fish meal market were not created maliciously. The Peruvian business man does not behave in this manner in the first place, and he would not deliberately create serious problems for himself in the second. The troubles arose through errors in judgment as to the capacity of the Peruvian fishermen to catch anchovetas and the capacity of the world to absorb their product.

Easy and Speedy

The incredibly rich stocks of fish off the Peruvian coast, untapped for centuries except by the birds, allow purse seine boats to fill their holds in a few hours. Many vessels make two or even three trips a day, coming back with full loads each time. Simple systems of meal reduction make it possible to transform the raw fish into bagged meal in two hours, from wharf to sack. Uncontrolled fishing could produce far more than even the disastrous levels of meal production

HOME FROM THE SEA. *At Port Monmouth, N.J., the fishing fleet is rafted at the dock during a weekend. But more of them will be tied up soon if marketing problems of the fish meal industry cannot be solved through international co-operation and action. The tall building is part of the menhaden reduction plant, where fish meal is produced. (N. Kenneth Ebbs)*

now prevailing, and some estimates put the foreseeable capacity of the Peruvian industry at 1,000,000 tons or more a year.

Perhaps the present unsettled situation of the world fish meal market is temporary. Solutions are being vigorously sought by the fishing industry and the governments involved. But "temporary" is a relative thing, and solutions may come too late to save many companies from financial disaster; efforts must be vigorous.

Suggested Solutions

One solution, suggested by Peruvians as well as by outsiders, is to limit the exports of Peru. Recently meal producers in Peru formed a marketing association, Consarcio Pesquera del Peru, and responsible elements of the Peruvian industry are examining the possibility of such restrictions.

Production of fish meal in Peru amounted to 383,600 metric tons in the first nine months of 1960. A meeting of the principal world fish meal producers held in Paris in October, 1960, estimated that world exports of this commodity in 1961 would approximate one million tons, and Peru's share of this was anticipated to be 600,000 tons, or 60 per cent. At the Peruvian industry's urging, the government of Peru was persuaded to abandon its traditional position of non-interference with free

enterprise, and on December 16, 1960, issued a decree which limits the fish meal exports of the country in 1961 to 600,000 tons. This is a huge amount, but at least world fish meal producers can now anticipate the maximum amount to be expected from Peru, and this will help in establishing minimum prices and avoid speculation and consequent price changes. Artificial control of production is never popular, of course, and probably does not offer a final satisfactory solution.

A second device, which would require more time but might provide a more lasting solution, is the encouragement of greater use of fish meal. It is commonly misconceived that fish meal is used principally or solely as fertilizer, although it is many years since this has been the case. The value of fish meal has increased greatly in the last two or three decades as a result of the discovery of its nutritive value as food for poultry and hogs, especially the former.

Chicken Feed

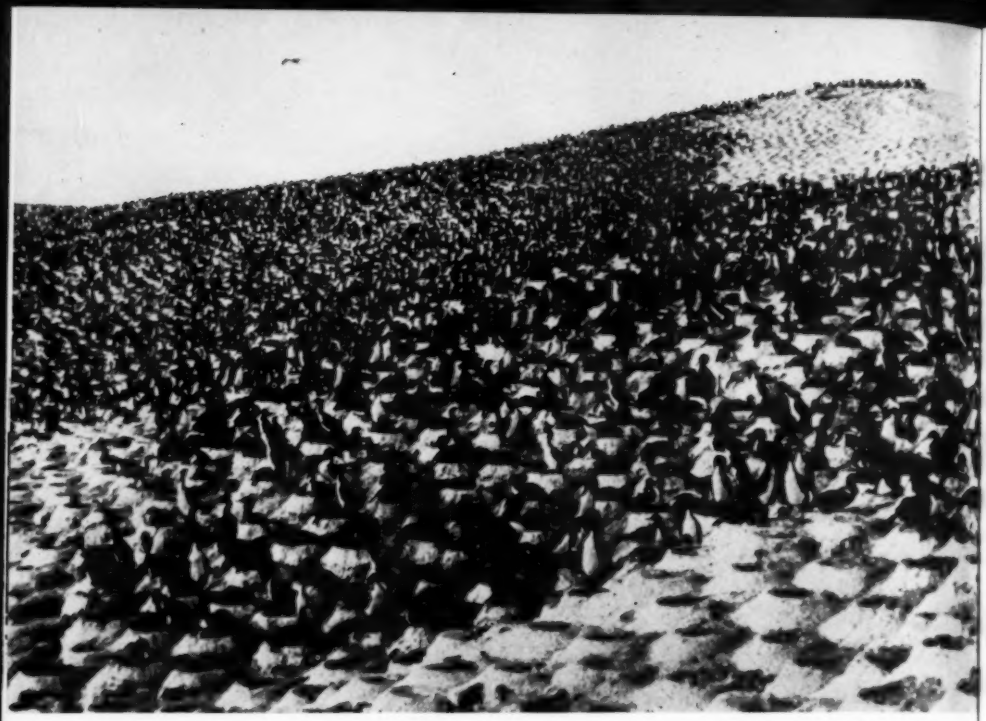
Growth of poultry is considerably accelerated if fish meal is added to the ordinary ration of grain, so that a chicken farmer can raise four broods for market where he formerly raised three. The health of chickens is also improved. In fact, the value of fish meal in the poultry industry is so well established that its use in chicken feed supports its chief market.

But there is still a huge potential for increased use of fish meal as a feed supplement. This is especially true in the United States, where it is already established but where much greater quantities could still be absorbed, and it is still more true in other parts of the world. France, for example, used only 50,000 tons of fish meal, compared to the 440,000 tons consumed in the United States. Russia, with its huge population, used only 45,000 tons, and other countries are proportionately skimpy in their consumption.

Edible Fish Flour

A third possible solution to the present overproduction of fish meal, and one which in many ways is of great significance to mankind, is the production of edible fish flour. It may be that we could partially solve the tragic anomaly of starvation throughout the world while such nutritious food is a glut on the market. To a very considerable extent the food problem of the world is not one of shortages but of inadequate distribution. Fresh fish is highly perishable, frozen and canned fish is expensive. If a cheap, palatable product could be made from the anchovetas of Peru, a product which could be shipped and stored without fear of spoilage, the dilemma of Peru and the rest of the fish meal-producing nations might very readily be promptly solved, and many a hungry child could be sent to bed well nourished.

Half of this requirement has been met in that a good quality of fish flour, with no objectionable flavors or odors, has been developed. The second problem, its manufacture at a low price, has yet to be solved. But



RIVALS OF THE PERUVIAN *fish meal industry are the guano bird colonies on certain islands off the Pacific coast. Peru is confronted with the question as to whether it should encourage its fish meal industry by permitting unrestricted fishing of the sea, or whether it should restrict fishing in order that there be ample food for birds which produce profitable guano. (Compañia Administradora del Guano)*

it can be, and there is every likelihood that the price of fish flour can be reduced so that it can become a major user of Peruvian anchovetas, as well as of Canadian and Norwegian herring and American menhaden.

New Concepts

The Peruvian anchoveta story illustrates clearly the principle that conservation of marine resources goes far beyond the mere guarding of the fishery stock from overexploitation. In the first place, the old concept that "conservation" always involves hampering restrictions of fishing must be discarded; instead, wisdom must be applied in deciding whether, in fact, more fishing should be encouraged if the full potential of the resource is to be realized.

In the case of the Peruvian anchovetas, the belief that both the guano birds and the fishermen could be supported by the fish stocks was justified. Then, even more dramatically in this case, it has been emphasized that a knowledge of the biology of the fish is not enough to realize the best use of a fishery resource, but that economics and sociology enter strongly into the picture.

Greatest Not Always Best

The *greatest* catch is not necessarily the *best* catch, and the optimum level of exploitation can only be determined by careful weighing of the capacity of markets to absorb the catch and of the effect of the production on the fishermen and on others whose welfare is affected.

Finally, the fish meal situation illustrates what is becoming increasingly clearer in all areas of human activity: What affects people in one country leaves its mark on a large part of the rest of the world. When overproduction of fish occurs in Lima, its impact is felt in Provincetown, in Hamburg, in Reykjavik, and in Capetown.

In affairs of state, we must cooperate and negotiate internationally if we are to survive.

Attention All Whale Watchers!

Cooperation on the part of a hotel owner at Fenwick, Delaware, enabled Dr. Charles O. Handley, Jr., of the division of mammals, Smithsonian Institution, to see and identify a rare species of small whale which had washed ashore on the hotel beach. Because the odor of the dead whale was not helping the hotel's business, the manager had hired a bulldozer to bury it. But he agreed to delay the burial until Dr. Handley could dash over from Washington.

The whale proved to be a *Ziphius cavirostris,* or Cuvier's beaked whale. Dr. Handley hastily measured it, and removed the head, which he took back to the National Museum for further study.

Dr. Handley is a member of the Committee on Marine Mammals of the American Society of Mammalogists. This committee is attempting to record all strandings of whales, porpoises, dolphins, seals, etc., on the coasts of North America. Anyone who sees or hears of a stranding of one of these animals is urged to get in touch with Dr. Handley, at the Smithsonian, Washington, D. C.

Add Scallops to Rockets

Cape Canaveral, the name almost synonymous with giant rockets and space missiles, now has another claim to fame. A huge stock of calico scallops *(Pecten gibbus),* apparently more extensive than any previously known scallop bed in the world, has been discovered along the east coast of Florida, within sight of the gantry towers and launching pads of Canaveral. Commercial concentrations were found over a 1,200-square-mile area by the *Silver Bay,* U. S. Fish and Wildlife research vessel, with indications that the bed might be even more extensive.

Power From The Tides

By J. L. McHUGH

Chief, Division of Biological Research
Bureau of Commercial Fisheries
Washington, D. C.

FOR HUNDREDS of years man has recognized the tides as a potential source of power, but his efforts to harness these forces have been notably inefficient. We know that tidal power was used to grind grain as early as the eleventh century; and that in the eighteenth and early nineteenth centuries many tide-mills were built in England and America. Some of these simply used a fraction of the tidal forces directly; the more advanced types, such as "Slade's Mill," built in 1734 at Chelsea, Massachusetts, stored power behind a dam; but none generated more than 100

HARVESTING FISH FROM A CART. *At Minudie, on the shores of the Bay of Fundy, fishermen gather their catch from horse-drawn carts when the enormous tide goes out and leaves fish trapped in gill nets high in the air. (Nova Scotia Film Bureau)*

horsepower, an insignificant fraction of the total energy available.

The development of electricity focused attention on the more easily controlled sources of power in rivers, and vast hydroelectric projects now utilize much of the energy available in many of our largest streams. But man has never failed to dream about taming the infinitely greater power of the tides, and his imagination has been stimulated rather than discouraged by the difficulties that have impeded his progress.

Tides Not Easily Harnessed

Why should it be so difficult to capture the forces of the tides? The answer is relatively simple, but the engineering and social problems are immense. The amount of power generated by a hydroelectric project depends upon the amount of water flowing, and the height, or head, from which it drops. The rise and fall of the tides in most parts of the world are slight compared with the difference in water level in most conventional hydroelectric projects, and the enormously large quantities of water needed to offset the relatively small head available from tidal movements usually prohibits such projects.

A few places in the world, however, have tides great enough for practical purposes, and none is more favorable in this respect than the famous Bay of Fundy, the home of the world's largest tides. Serious efforts to harness Fundy's tides have been underway for about forty years, but opinion still is divided as to the economic feasibility of such a project.

First Plant in France

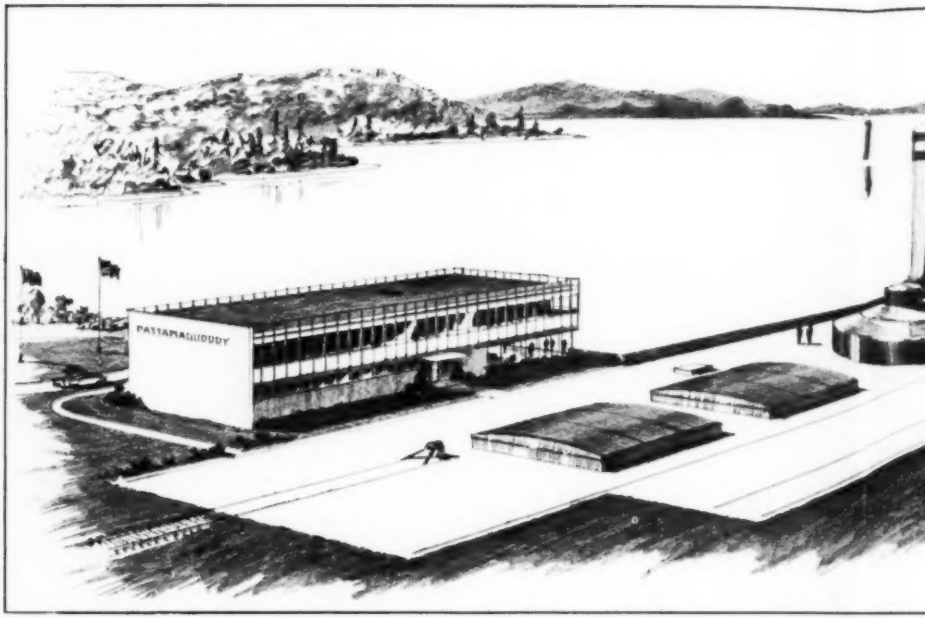
Feasibility studies for large tidal power plants have also been made in the estuary of the Severn River, in England; L'Aber Vrach Bay and Mont St. Michel in France; and San José Gulf in Argentina. But the first large-scale tidal power plant in the world may be built on the estuary of La Rance River, on the coast of Brittany in France, where certain components are already being tested.

Formidable difficulties face the tidal power engineer. The direction of flow reverses twice a day, and with it the available energy fluctuates, from zero at the moment of reversal, or slack water, to a maximum at full flood or ebb. Even more distressing are the changing times of high and low tide each day, caused by the fifty-minute difference in period of orbit of earth and moon; and the regular fourteen-day variations in the relative positions of earth, moon, and sun. Thus, any power project that depends upon the tides will be a fluctuating source of power, and the fluctuations will be linked neither with time of day nor with season—certainly not with the fluctuating demands of the users of electricity.

Zero Twice a Day

Any power project must produce benefits that clearly exceed the costs of construction and operation, otherwise it cannot be justified economically. The hydroelectric project of today, furthermore, must be able to guarantee a certain level of power production, if it is to attract customers.

The principle of the old-fashioned



ARCHITECT'S SKETCH *of the proposed Passamaquoddy Power House at Moose Island, Maine. It which has the greatest extremes of tide in the world. Several sources of auxiliary power storag*

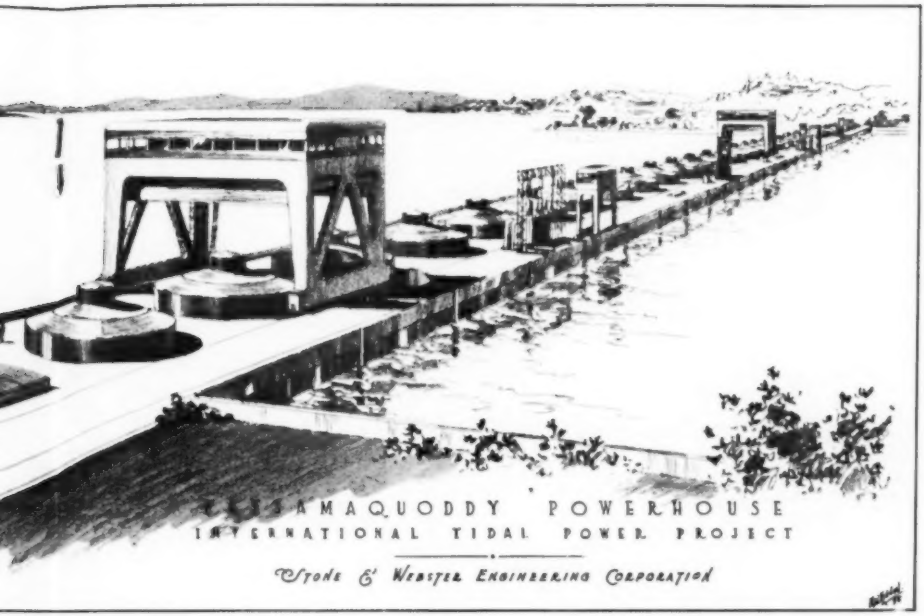
tide-mill would be of no interest to modern industry, for the power produced would fluctuate constantly and would reach zero about twice a day. The difficulties that have stifled use of this power source are related to the problem of creating uniformity in power output. Many methods are known, but only the major types need be considered here.

The simplest type of improvement over the direct-drive method is to place a dam across an arm of the sea, creating a reservoir which can be filled at high tide and drained at low. Various methods can be used to increase the efficiency of such a system, but even the best of these will leave periods in which no power can be generated.

A better arrangement is to create two pools, one of which is filled at high tide, the other of which is closed at low. A continuous, though variable, flow of water in one direction can be maintained from the high to the low pool.

Several arrangements of pools and power units are possible, and the best of these produce power continuously, but power output is variable. Even the most favorable plan produces twice as much power at certain tidal stages as at others.

The guaranteed power output of purely tidal projects, therefore, coin-



nd, Maine. It would generate electricity from tides that daily rush in and out of the Bay of Fundy. power storage and supply have been considered by engineers. (U.S. Army Corps of Engineers)

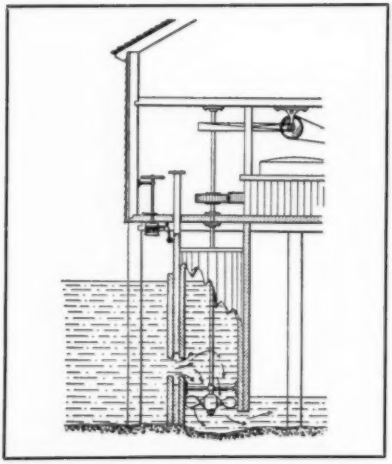
cides with the minimum, and this is neither efficient nor economically sound. The obvious answer is to provide an auxiliary source of power, which can act somewhat as a storage battery, building up power when the tidal output is high, and supplementing lower levels of output.

Passamaquoddy Investigations

The criteria for selection of a site for such a project depend upon topography as well as on tidal rise and fall. The upper end of the Bay of Fundy, where tides are highest, has been considered as a possible site by Canada, but the region that has received greatest attention is near the lower end, lying athwart the eastern end of the boundary between Canada and the United States.

Passamaquoddy Bay, almost entirely in Canada, and Cobscook Bay in the United States, have been under serious consideration since 1919, when a private organization, Dexter P. Cooper, Inc., was granted permission by the two governments to investigate, and possibly construct, a power project. Adverse effects upon the fisheries predicted by Canadian scientists and failure to obtain loans to support a purely United States project caused the project to fail.

Revival of active interest in the project undoubtedly arose through the



HOW TIDE MACHINERY OPERATES. *This simple diagram shows how an incoming tide used its power against a turbine, which turned a shaft geared to the mill's various operations. An outgoing tide reversed the mechanism. All operations ceased when the tide was at full flood or ebb. (From* The Spice Mill on the Marsh, *by Thomas P. Smith. Courtesy D. & L. Slade Co., and Chamber of Commerce, Chelsea, Mass.)*

efforts of the late President Franklin D. Roosevelt, who spent his summers on Campobello Island and was impressed with the potentiality of 'Quoddy to provide an assured source of cheap power for New England and New Brunswick. He was not able to arouse interest in Canada for an international project, and so it was decided to begin in a small way to develop a single-pool project entirely within United States territory.

The President hoped that Canada might be more interested in the proposal once work began. The depression of the 1930's also gave justification for the project, for it provided work in a seriously distressed area. This social-welfare aspect led some people to doubt the economic soundness of the international plan. In the late 1930's the United States Army Corps of Engineers commenced construction and built three dams, which still exist, forming highway links from the mainland to Eastport, Maine, and separating Cobscook Bay from Passamaquoddy Bay. But the project was abandoned long before completion because Congress did not continue to appropriate funds.

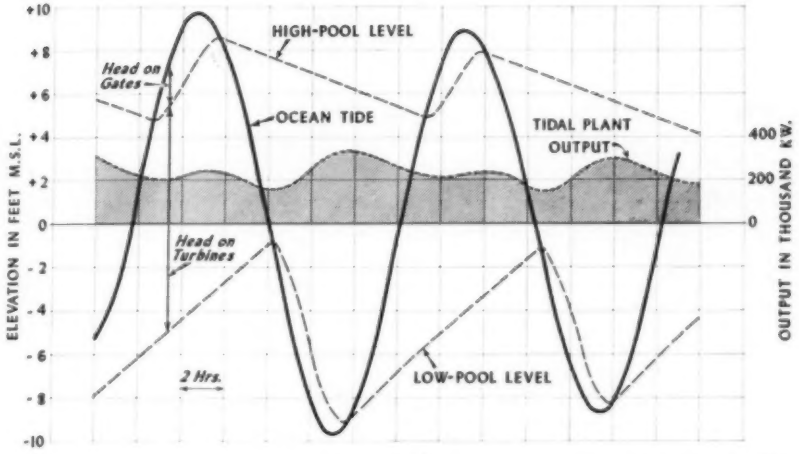
Referred to Two Boards

In 1956 the Governments of Canada and the United States referred the problem to the International Joint Commission. The Commission appointed two Boards to study the question, the International Passamaquoddy Engineering Board and the International Passamaquoddy Fisheries Board.

The work of these Boards was completed late in 1959, and the Board members briefed the International Joint Commission in Boston, Massachusetts, in January, 1960, explaining the engineering, economic, and fishery aspects of the problem.

Fisheries of the 'Quoddy Region

Herring is the most important commercial fish species in the area, but cod, haddock, flounders, redfish, hake, pollock, salmon, alewives, smelt, clams, scallops, and lobsters also contribute to the fishery harvest. Landings of "sardine" herring at United States and Canadian ports from the 'Quoddy region have fluctuated about an average of fifty-five mil-



TYPICAL TIDAL PLANT OPERATION. *Reduced to a chart, here is how the cycle of tides, pool levels, and power output looks to an engineer. Each square (horizontally) represents two hours of time; (vertically) two feet above or below mean sea level. (U.S. Army Corps of Engineers)*

lion pounds annually, worth nearly a million dollars at current dockside prices. In the processed form, this annual catch is sold for about five million dollars.

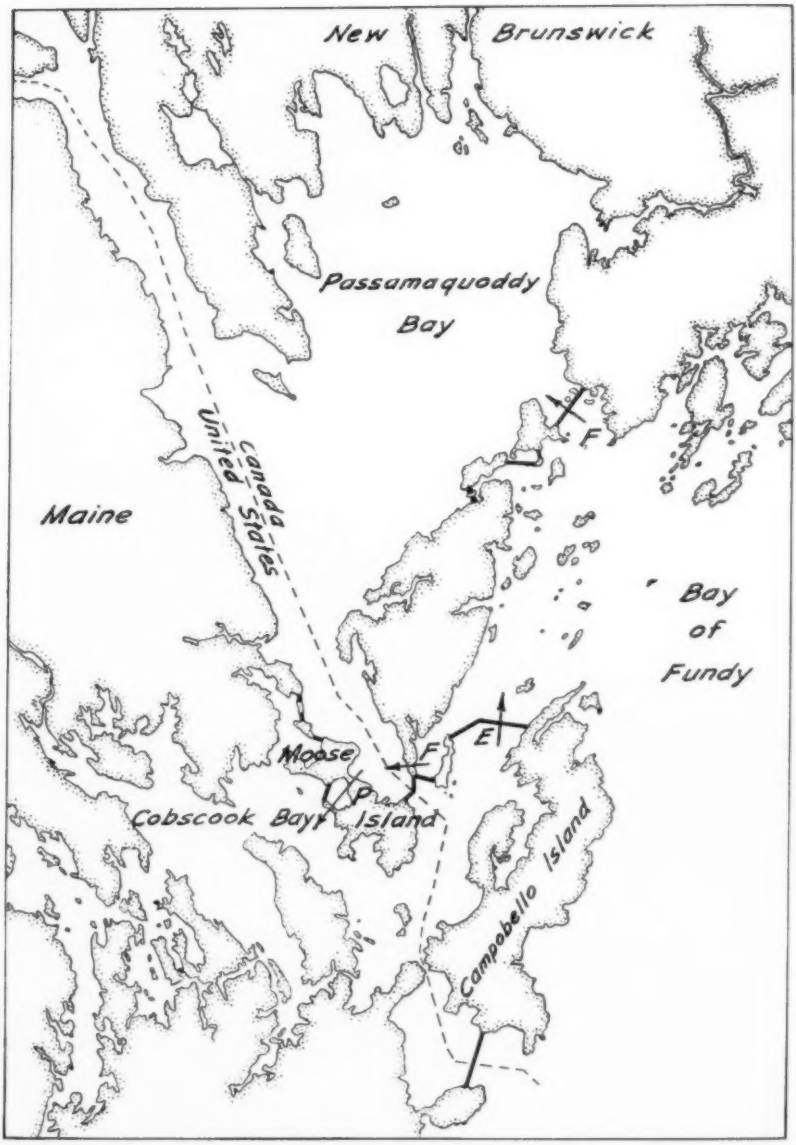
Considerable quantities of herring also are canned as pet food, and some are processed as fish meal, oil, and solubles. Almost eleven million dollars worth of herring products were produced in 1957 in the United States part of the Passamaquoddy region. In both countries herring have made up slightly over 50 per cent of the total value of fishery landings in 'Quoddy in the past ten years. Salmon and trout also are sought by sport fishermen.

Recent Evaluation of Project

The Fisheries Board made extensive investigations of the oceanography and fisheries of the region and concluded that although pronounced environmental changes would take place within the impoundments, the total effect upon the fisheries would be slight, and no significant effects would be felt beyond the immediate influence of the dams and gates. It was predicted that some fisheries would suffer, others would benefit, and still others would be unaffected.

If the project is authorized and constructed, a check on the accuracy of these predictions will be of inestimable value to fishery science everywhere, for it will test our knowledge of the effect of environment changes on marine animals.

Mean water level will be raised about 6 feet in Passamaquoddy Bay and lowered about 5 feet in Cobscook Bay. Current patterns within these bays also will be altered substantially,



TWO NATIONS WOULD SHARE *the benefits of the International Tidal Power Project, and two bays. Passamaquoddy and Cobscook, would be dammed to form high and low pools. Filling gates are designated by "F", emptying gates by "E", and the power unit by "P." Locks would also be provided. (Map from author)*

for the emptying and filling gates will be closed during about three quarters of each tidal cycle. The diminished velocities will reduce vertical mixing of the water, causing increased stratification, with reduced salinity in the surface layers. This will increase the possibility of ice cover in winter, and will increase surface water temperatures in summer.

Herring found in the 'Quoddy region are part of a large population that is widely distributed throughout the Bay of Fundy and the Gulf of Maine, hence damage to the herring fishery is expected to be indirect, caused by the need to relocate some weirs, to lengthen stakes on some to allow for increased water depth, and perhaps to replace weirs more frequently because wood-borer activity may increase. Damage to the lobster fishery also will be indirect, caused by the need to relocate lobster pounds, refrigerate water, or extend intake pipes, to compensate for higher surface water temperatures.

The clam fishery will be affected most seriously, for changes in water levels will produce drastic changes in

THIS MUCH IS COMPLETED. *Dams or causeways built in the 1930's by the U.S. Army Corps of Engineers link Eastport, Maine, with the mainland. While they separate Passamaquoddy (right) and Cobscook (left) Bays their principal use today is for a highway. Eventually they could be worked into the tidal power project. (U.S. Army Corps of Engineers)*

"PACKED LIKE SARDINES IN A CAN" *is an old expression, and these women in a Maine sardine cannery show how it is done, with skill and dispatch. Maine sardines are somewhat larger than most of the imported species, and are a meal rather than a tidbit. Total effect of the proposed dams upon the fishing industries of the 'Quoddy region such as sardine canning would be slight, it is estimated. (Richard Merrill, Melrose, Mass.)*

the environment. This will reduce the clam population to a very low level for a few years until new populations can become established farther up the beaches on Passamaquoddy grounds, lower down in Cobscook Bay. At the new water levels suitable bottom for clams will be reduced in area, hence the clam resource is not expected to regain its present level of production.

To balance this and other losses it is predicted that conditions for certain other species, such as winter flounders, scallops, lobsters, and anadromous fishes like salmon, alewives, shad, and striped bass will improve.

Will Balance Out

If compensation is provided for indirect damage to fishing installations, it is not expected that the fisheries as a whole will suffer, for losses and gains in biological productivity will balance.

WEIRS TRAP UNWARY HERRING. *This important fishery would be only indirectly affected by tidal dams. Herring do not spawn in the 'Quoddy region, but move in as young. Some weirs would have to be relocated; others would have to have stakes lengthened to allow for increased water depth. (Courtesy Dr. J. L. Hart)*

The Engineering Board evaluated various modifications of the one- and two-pool plans and recommended a scheme in which Passamaquoddy Bay would be dammed to form a high pool, Cobscook Bay would be enclosed to form a low pool, and the powerhouse would discharge from the high to the low pool.

Several sources of auxiliary power storage and supply were considered, such as the one which would require pumping of Passamaquoddy Bay water into a reservoir created by damming the Digdeguash River estuary, at the northern end of Passamaquoddy Bay, another of which would place a conventional hydroelectric dam across the Saint John River at Rankin Rapids. The Rankin Rapids site was judged most efficient economically. Total costs, including several alternative auxiliary power sources, have been estimated at 277 to 337 million dollars for the United States share and 289 to 315 million dollars for Canada.

Approval of the project will depend on many things. Ultimately, of course, the decision will be made on the

basis of economic gain. It is by no means certain that the various factions: industry, commercial fisheries, sport fishermen, lovers of wilderness areas, and politicians, will reach agreement on the ratio of benefit to cost. Whatever the result, however, the Passamaquoddy project will remain a monument to man's imagination and to his urge to put one of the most powerful forces of nature to useful work.

AUTHOR'S NOTE: As this article goes to press, a news item datelined St. Malo, France, appeared in the *Washington Post* on January 8, 1961. The release states that a prototype of a combination turbo-generator and pump, known as a "bulb unit," installed in a lock is producing 12,500 horsepower from tidal forces. It is said that this unit is over 90 per cent efficient when used as a turbine and over 70 per cent efficient when used as a pump. This combination of operations solves a principal difficulty in harnessing the tides; namely, that it compensates for the lack of phase between tidal cycles and peak power demand.

New Mariners Atlases

To the ordinary layman a marine atlas, giving data on average currents and weather conditions in certain areas of the sea, does not make for very exciting reading. But to all those who sail the high seas, whether they be professional mariners or amateur yachtsmen, such publications are invaluable.

The last in a series of five British atlases, giving the world-wide coverage of the oceans, has just been released by the Marine Division of the British Meteorological Office. Numbered M.O. 655, it is entitled: "Quarterly Surface Current Charts of the Eastern North Pacific Ocean."

The charts have been compiled from observations of surface currents reported to the Meteorological Office by volunteer marine observers in British merchant ships (*Sea Frontiers,* Vol. 5, No. 3, "Meteorology and the Sea," by C. E. N. Frankcom), and from observations made in H.M. ships and forwarded by the Hydrographer of the Navy.

These charts are similar, but more detailed and cover a longer period of time (1855-1952) than those issued by the U. S. Hydrographic Office, and by German and Japanese government agencies. The British operate more merchant ships and therefore are in a position to give more complete reports. The charts are not designed solely for British pilots, however, and, with the increasing exchange of such information, sea atlases are becoming more and more alike.

Woods Hole Series

Almost simultaneously, Woods Hole Oceanographic Institution announces a new series of oceanic atlases with the launching of Volume One, "The Atlantic Ocean Atlas of

ALTHOUGH GROSSLY INACCURATE, *this map of the New World, published in Ptolemy's famous "Geographia Universalis" in 1540, represented the most up-to-date information of its period. Modern marine atlases not only define the continents with great accuracy, but give data on average currents, temperature and salinity, from the surface to the bottom, in many areas. (From an old print)*

Temperature and Salinity." A part of the Institution's contribution to the International Geophysical Year, the book contains 46 large colored charts, or profiles, showing the salinity and temperature of the North and South Atlantic Oceans from the surface to the bottom.

Hidden Sea Vitamins?

An intriguing sea quest has been launched by the Beaudette Foundation for Biological Research, of Solvang, California. Scientists there are interested in a mysterious strip of the Pacific Ocean, stretching from Panama to Baja California, Mexico. In that area, fish grow to tremendous sizes and seem to be immune from disease.

Research is expected to reveal whether the water contains some medical ingredient which might benefit man.

UP FROM THE DEPTHS *of the tropical Pacific comes a deep sea trawl. Alexander Agassiz (in business suit!) watches from a vantage point on the deck of the* U.S.S. Albatross *as the net unloads its strange cargo. Alexander Agassiz revolutionized the methods of oceanographic research of his day, inventing several important new pieces of apparatus. (Reprinted with permission from* Founders of Oceanography and Their Work, *by Sir William A. Herdman. (c) Edward Arnold, Ltd., London)*

Trailblazers in Oceanography

By C. P. IDYLL
Marine Laboratory, University of Miami

LOUIS AND ALEXANDER AGASSIZ, father and son, probably had more influence on the course of research and teaching in biology in general, and marine biology in particular, than any other two men in the history of the United States, let alone any two men from one family.

And yet, Louis was a dogmatic opponent of Darwinism, and the marine laboratory he founded, and on which part of the claim for his influence on marine biology is based, was run by him for only three months, closing the year after he died.

Teacher Who Disliked Teaching

Furthermore, his son, Alexander, was a highly successful mining engineer, making sufficient income at this profession to be able to give over a million dollars to further the cause of marine science. Alexander disliked teaching, and, as a final compounding of the anomoly, this giant in American science remained all his life something of a foreigner, thinking in his boyhood French language, instead of in English.

These contradictions fade as mere curiosities, however, when the monumental achievements of the two men are considered. Louis is described as the ablest teacher of science America has known, and is credited with firing enthusiasm for science in the breasts of not only a great many students, but business men and the public.

His short-lived marine laboratory, which virtually died with him, provided a spark that caught fire, the effects of which are still being felt in the marine laboratories around the country, where research and teaching in marine biology and oceanography gain momentum daily.

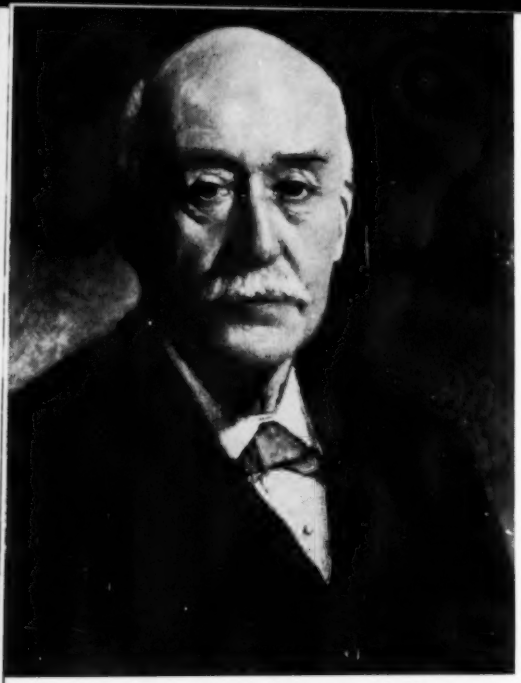
Louis started the Museum of Comparative Zoology at Harvard, while he was a professor there. The principles he laid down, and the fiery energy he applied to their early development, are to a great extent responsible for its position as one of the distinguished museums of the world.

Alexander's career, although different, was even more distinguished strictly in terms of marine science. He was a fine zoologist, and produced some of the best studies of the day. He revolutionized the methods of oceanographic research, inventing several important new pieces of apparatus.

Disclosed Sea Floor

As a result of his many voyages, he provided more knowledge of the structure and configuration of the sea floor than any other man of his era. He made the marine fauna of the West Indies the best known of any in the world at the time.

The elder Agassiz, Jean Louis Rudolphe, was born in 1807 in a small village near Neuchatel, Switzerland. It is of interest to note that Pasteur



LOUIS AGASSIZ FOUNDED *the first marine laboratory in the United States, and, while it lasted only three months and virtually died with him, it provided a spark which caught fire. The effects of his teaching and this pioneer attempt to set up a marine station are still being felt in laboratories around the country, as research and teaching in marine biology and oceanography gain momentum daily. (Harvard University News Office)*

and Cuvier, two other giants of nineteenth century science, were born in the same small district of Switzerland, at about the same time. The intellectual climate of the region seems to have been favorable for the flowering of able minds, and this is undoubtedly why Agassiz's Protestant forebears had sought refuge there when they left France some generations previously.

Louis' education was a long and complicated one. First, he attended the Gymnasium at Bienne, and college at Lausanne. Then, in succession, the Universities of Zurich, Heidelberg and Munich, earning both the degree of Doctor of Philosophy and Doctor of Medicine.

His First Fish Project

While he was still a student, Agassiz was entrusted with an important assignment which set his course in the direction of ichthyology, and influenced his subsequent interest in marine science. Two distinguished Swiss zoologists, J. B. Spix and C. P. J. von Martius, had made extensive collections of the fresh water fishes of Brazil. These had begun to be classified when Spix died in 1826. Martius thereupon turned the collections over to Louis Agassiz, a promising young science student. Agassiz grasped the opportunity with enthusiasm, and the result was a notable report, published only three years later. Louis was at that time only twenty-two.

There then followed researches on the fresh water fishes of Europe, and on fossils, which put him in contact with such influential scientists as Cuvier and Humboldt. These friendships, particularly that with Humboldt, were important to Agassiz, since they helped him to get, first, the appointment to the new Chair of Natural Sciences at Neuchatel, then a subsidy from the Prussian crown.

The combined strain of getting his education finished, and of carrying on his research, however, had made Agassiz's financial situation precarious, so that these appointments were critical to his career, allowing him to pursue his work.

Now came the real turning point, an invitation to give lectures on science in Boston. These were enormously successful. Agassiz proved to be an extraordinary lecturer. Inevitably more lecture invitations followed, and the result eventually was that Agassiz stayed in the United States, accepting a new Chair of Natural History at Harvard.

Undoubtedly Louis Agassiz's chief fame came as a result of his great skill as a teacher. His enthusiasm and energy stimulated his students, while his personal warmth and generosity endeared them to him and spurred them to perform well. He had an extraordinary command of English, and apparently captivated audiences of all kinds.

"Little Renaissance"

Agassiz's philosophy of teaching is important, since it had a great influence on the course of science in America and throughout the world. He was impatient with book learning, and urged his students to observe nature directly. This was the heart of the philosophy of the Renaissance, of course, whose insistence on learning first hand, instead of repeating the statements contained in books, lifted the world out of the stagnation of the Dark Ages.

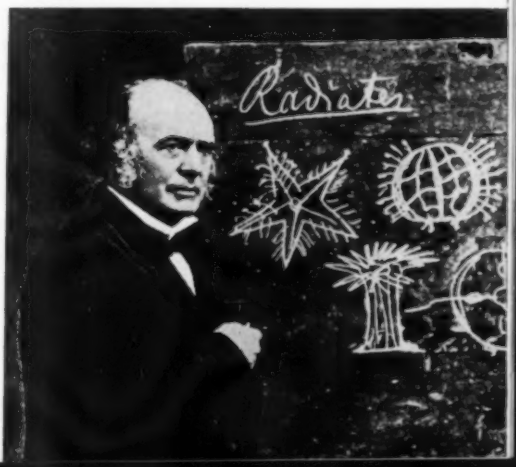
Agassiz's "Little Renaissance" in Boston set a new direction to the course of science in America. His philosophy is contained in the statement "If you study nature in books, when you go outdoors you cannot find her."

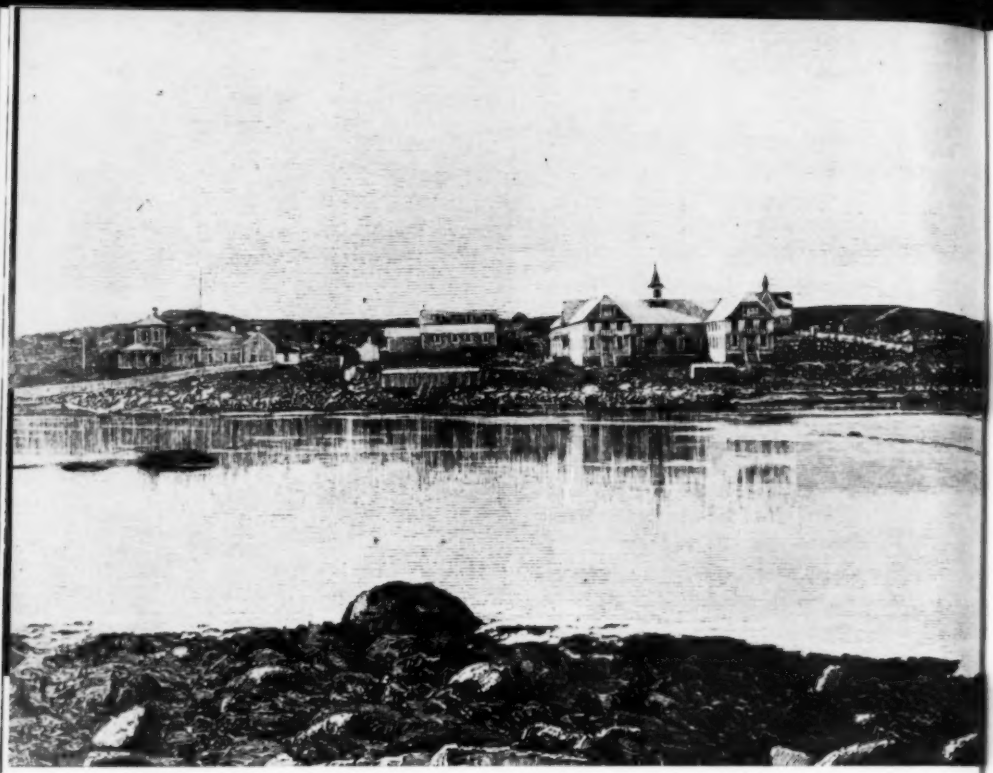
Agassiz's interest in oceanography began in earnest in 1847 when he made observations of the ocean aboard vessels of the U.S. Coast Survey. Later he conducted important observations of the structural nature of the Florida reefs and the Keys, describing the geology of the Florida Peninsula and of the Dry Tortugas. Dredging expeditions followed in the West Indies and around South America, from Florida to San Francisco, and Agassiz's reputation as a marine scientist grew.

Pioneer U.S. Marine Station

Louis never stopped talking and writing about his activities, and an account of an appeal that he made to the Massachusetts legislature for support for a seaside marine laboratory was printed in a New York newspaper, where it was read by a wealthy merchant of that city. Mr. John Anderson was intrigued by this idea and

ALEXANDER AGASSIZ, *son of* Louis, *carried on the broad scientific interests and traditions of his father. His career, while different, was even more distinguished in terms of marine science. On expeditions to Atlantic, Pacific and Indian ocean areas he obtained more knowledge of the structures and configuration of the sea floor than any other man of his era. (Museum of Comparative Zoology, Harvard)*





THIS IS "PENIKESE," PIONEER *marine laboratory in the United States. Louis Agassiz never stopped talking or writing about his activities. An appeal to the Massachusetts Legislature for a seaside marine station was read in a New York newspaper by Mr. John Anderson, a wealthy merchant, who promptly offered the island of Penikese, at the mouth of Buzzard's Bay, Massachusetts, including its buildings, and a gift of $50,000. But the station closed within three months. (Reprinted with permission from* Louis Agassiz: His Life and Correspondence. *(c) Houghton Mifflin Company, Boston).*

offered the island of Penikese, at the mouth of Buzzard's Bay, in Massachusetts, for the undertaking.

A gift of $50,000 was also made by Mr. Anderson to convert the existing buildings on the island into a laboratory, and in this manner the pioneer marine station of the United States came into being (1873).

Agassiz's boundless enthusiasm and energy are nowhere better illustrated than in the establishment of the Penikese laboratory in the last days of his life. Anderson's offer was made in the early summer, and through superhuman effort the school was actually in operation by July 8, with about fifty students in attendance. It was his last effort, however, for he died that same year.

Genesis of Woods Hole?

The laboratory did not survive long, being closed by Alexander Agassiz the following year. Its importance is great, however, since it provided the stimulus for other lab-

oratories around the country, and undoubtedly influenced the founding of the famous Woods Hole laboratory in 1898, only a few miles from the old Penikese site.

Louis Agassiz's most enduring monument is the Museum of Comparative Zoology at Harvard. Agassiz was a great collector, and one of his early activities, after becoming part of the faculty at Harvard, was to start the museum. Its first home was an old wooden shanty on pilings on the banks of the Charles River.

More Than Mere Collection

Agassiz's concept of the museum was that it should be far more than a mere collection of specimens. Instead it was to serve as a tool for research in natural science, and, in particular, as an aid in teaching. In the words of his wife "—he hoped to make his ideal museum a powerful auxiliary in the interests of the schools and teachers throughout the state . . . He hoped it would become one of the centres for the radiation of knowledge, and that the investigations carried on within its walls would find means of publication, and be a fresh, original contribution to the science of the day."

The museum soon moved from the wooden shack, and in 1860 a new building was dedicated. Agassiz's hopes for the museum were fully realized, and its publications are among the most distinguished and useful in the field of zoology.

OVERLOOKING THE FLORIDA STRAITS, *birthplace of the Gulf Stream, the Agassiz Building of The Marine Laboratory, University of Miami, recalls that Louis Agassiz conducted some of his earliest field work in oceanography along the Florida reefs and keys. The Agassiz Building is on Virginia Key, 3½ miles from the mainland city of Miami. (E. John Long)*

The Museum of Comparative Zoology would not have attained its present eminence, however, without Louis Agassiz's son, Alexander, who was born in Switzerland in 1835, before his father moved to the United States. His mother died, and Alexander went to Boston to join his father in 1846, when the boy was eleven years old. He attended Harvard, obtaining his A.B. in 1855. There followed training as a mining engineer in the Lawrence school of science at Harvard, with a B.S. degree in 1857.

He worked on the U.S. Survey of the Washington Territory in 1859, in the course of which he collected marine animals all the way from Panama to Puget Sound. Hence, from the beginning, his interest in marine science was manifest.

Meanwhile, however, he set about earning a living — something many embryo marine biologists wish they could find a means of doing. Alexander became superintendent of the Calumet and Hecla copper mines on Lake Superior. These mines were failures at the time Agassiz assumed their management. His success with them was nothing short of spectacular. He made the Calumet, in terms of output, the greatest copper mine in the world. The company declared the largest dividends of any metal mine in the world, before or since. As a stockholder, as well as superintendent, he profited richly from his skill, and reaped a great fortune.

This money he now began to spend on marine expeditions. He threw himself into this activity with great energy, spurred to work by the death, within eight days of each other, of his father and his young wife. Crushed by this double disaster, he was ill-equipped at the moment to cope with the growing pains of the new marine laboratory at Penikese. John Anderson, the donor of the land and the original granter of funds, had lost interest in the venture. Efforts to raise money by public subscription failed, and the geographic location of the laboratory, on an island eighteen miles from shore, made it unsuitable for its purpose. Agassiz paid the debts of the laboratory and closed it.

Given a Free Hand

His first great cruises were with the *Blake,* a survey vessel of the United States Coast and Geodetic Survey. The government had the great foresight to allow Agassiz a free hand in the conduct of the cruises, and the results were reports of immense scientific value. The commander of the *Blake* when Agassiz first sailed on her was Captain C. D. Sigsbee, who achieved fame as the commander of the battleship *Maine* when she was sunk in Havana harbor, and for whom one of the notable deeps of the ocean is named.

With Sigsbee, Agassiz made several important improvements in oceanographic research gear. One of the simplest, yet most important, was the substitution of wire rope for hemp in towing cables. This at once increased the strength of the cables, reduced their weight and their cost, and the space required to store them.

The new warps of galvanized steel,

MONUMENT TO LOUIS AGASSIZ *is the Museum of Comparative Zoology at Harvard, who founded it in a wooden shanty on pilings along the banks of the Charles River. It would not have attained its present eminence, however, without the encouragement of his son, Alexander. More than a mere collection of specimens, the museum has served as a tool for research in natural science for more than a century. (Museum of Comparative Zoology, Harvard)*

with a hempen core, were 1⅛ inches in circumference compared with 2½ inches for the old hemp ropes; they weighed half as much as the old type and they had a breaking strain of about four tons compared with two tons for the hempen ropes formerly in use. The time required now to make a deep dredge haul was greatly reduced.

New Type of Dredge

Sigsbee and Agassiz also invented a new type of dredge which would operate regardless of which way it fell to the bottom, avoiding unsuccessful hauls that often resulted from old type dredges falling upside down when they reached the bottom. Since this mishap could not be detected until a long and tedious haul was over, it was a serious defect in the gear.

The last piece of new gear that might be mentioned was an ingenious closing plankton net which could catch plankton at any fixed depth, and be closed while it filtered water during its trips down and up from that depth.

The cruises on the *Blake* were

followed by others, especially those on the *Albatross*. This latter ship was built expressly for oceanographic work, and was commissioned in 1882. She was 200 feet in length, with a displacement of 2000 tons. Capable of dredging to 3000 fathoms, she worked mostly in the tropic Pacific.

Under the guidance of Alexander Agassiz she accumulated more knowledge of the seas than any other ship up to that time. One of her dredge hauls, from 1760 fathoms, brought up more deep sea fish than all the hauls of the *Challenger*.

It was characteristic of Agassiz to avoid theories. Instead he ordinarily contented himself with a careful cataloging of facts. One theory that he did advance as a result of his many dredgings was that pelagic life did not exist below 360 meters, and that the animals that occupied the abyss stayed close to the bottom. This left, thought Agassiz, a great intermediate lifeless zone.

This concept has since been shown to be quite wrong—as wrong, in fact, as his father's idea that the great depths of the ocean would prove to be the repository for living fossils of all kinds.

If Agassiz was wrong in this theory, however, he was careful not to advance one in regard to the origin of coral reefs, a subject of very great interest to him. It may be that this interest was related to antipathy to Darwin and his ideas that Alexander had apparently inherited from his father. The younger Agassiz adopted more readily the concepts of evolution, but Alexander rejected another of Darwin's famous ideas, to the effect that coral reefs were formed through the subsidence of the reef area. He spent a good portion of the last thirty years of his life thinking about this problem, and examining reefs all over the world. While he effectively disposed of Darwin's view, he never constructed an opposing theory.

In fact, if any criticism could be made of this remarkable man and his scientific endeavor, it would be that he showed a certain diffusion of purpose in his studies. There was, perhaps, a little too much of the purposeless collector about him, and an obscurity of meaning in his writings.

Yet his story cannot end on a carping note. He was a man of large and generous temperament, a first-rate zoologist, and a benevolent despot, whose life of service to science leaves us all in his debt.

"Tap the Ocean Depths..."

"Let both sides join to invoke the wonders of science instead of its terrors. Together let us explore the stars, conquer the deserts, eradicate disease, tap the ocean depths and encourage the arts and commerce." From the inaugural address of President John F. Kennedy, at the Capitol, Washington, D.C., January 20, 1961.

UN-STREAMLINED! *Fish experts are puzzled as to the manner in which the bill of this large striped marlin became bent so far out of line, and how the fish ever fed. It was caught alive off Avalon, Santa Catalina, California, in August, 1959. Opinions or theories will be welcomed by the editors. (Gene's Photo and Rock Shop)*

How Did It Get That Way?

When an enthusiastic fellow of The International Oceanographic Foundation sent this photograph of a deformed marlin to the Foundation's headquarters in Miami, he launched a series of lively discussions and speculations among game fishermen, marine biologists and others interested in the life and wonders of the sea.

First, here is what is definitely known: The fish is a striped marlin. It was caught alive from a boat off Avalon, Santa Catalina, California, in early August, 1959. The photograph was taken by a commercial photographer.

Marlin With Two Bills!

Now, *how* did it get that way? Among those who hazarded an opin-

ion was Colonel John K. Howard, a member of our Board and an eminent authority on the billfishes of the world:

"The marlin is without question a striped marlin. The type of stripes which show in the picture are characteristic of this species, and not of other Pacific marlins. Other characteristics, such as the height of the peak of the first dorsal fin, also indicate it to be a striped marlin. In addition, 98% of the marlin caught in these waters are striped marlin.

"Deformed bills are common to marlin and sailfish. I have seen bills broken off at any place between the point and the head, and healed over. I have even seen a marlin with two bills!

"The deformity shown in this photograph is unusual and it is hard to see how the fish ever fed. I have always felt that a deformity of the bill was the result of an early injury, which did not stop the growth of the bill.

"In this case it is hard to explain what sort of an injury occurred, if any. Both the bill and the upper and lower jaw are affected. The lower jaw appears to be much longer than normal and the extremity is crooked and unusual. If this deformity was caused by a blow, it would seem as though the blow must have altered both the upper and lower jaws. I suppose that it is possible that abnormal growth like this might be caused by some interference with normal hormone action."

Asked about the latter, Dr. Charles E. Lane, physiologist of The Marine Laboratory, University of Miami, ventured the following: "Unless there is a well-established sexual dimorphism in the bills of marlins, or unless it can be shown that the adult bill morphology is a sex-linked character, I would still think that this is the result of an early injury. I know of no evidence which would suggest that gonadal, or indeed any, hormones influence the growth or development of the bill specifically."

The consensus of other opinion was that this particular marlin probably made a gross error in navigation while travelling at high speed and rammed into a rock or other obstruction; or it may have been the victim of some hot-rod boatman. On one point there was complete agreement — while the marlin's streamlining was virtually ruined, its prospects of scooping in more food from a school of fish were probably enhanced. At any rate, there were no signs that the big marlin was suffering from malnutrition.

If the readers of *Sea Frontiers* have any theories on the cause or origin of such deformities, the editor would be glad to hear from them.

Fish Can Drown Bird Attacker!

One of the most spectacular of the birds of prey is the osprey, or fish hawk, which can dive beneath the water to catch fish with its sharp talons. Sometimes, however, the osprey overreaches itself, grabbing a fish too big to lift. When it cannot release its grip, the osprey drowns.

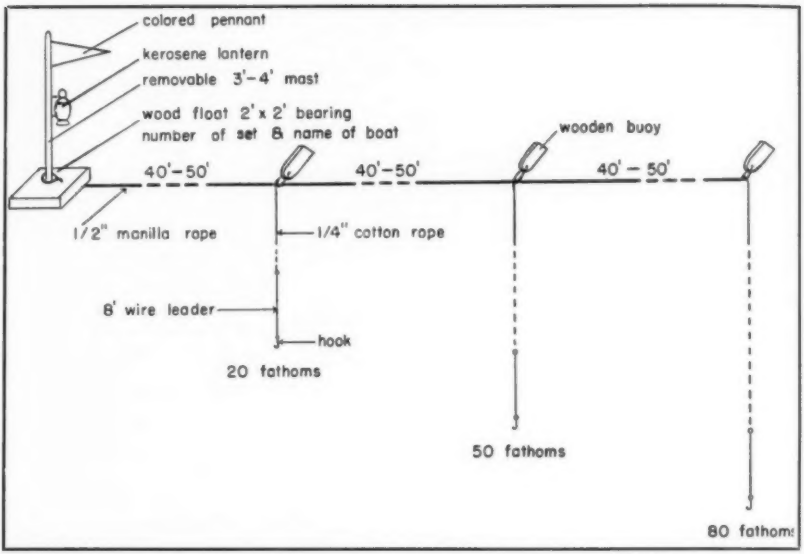
REMOVING A SHARK SKIN *calls for skill and experience. A shark's body is just a mass of cartilage and flesh, with no bones except the jawbone, but a good Cuban skinner can do the job in from three to four minutes. (Photograph from author)*

Fishing At Cojimar

By PERRY W. GILBERT
Cornell University

ONE OF THE MOST picturesque fishing villages in the West Indies is Cojimar, about ten miles east of Havana, Cuba. This is the town and these are the fishermen that formed the backdrop for Ernest Hemingway's "The Old Man and the Sea," and it is here at Cojimar that natives for generations have employed with conspicuous success an unusual method of sea fishing.

Each evening, between nine and eleven, fishermen put out from Cojimar harbor in their small boats, only eighteen to twenty-four feet over-all, and head for the deep water of the



IT LOOKS CRUDE *but is very successful. The floating fishing rig used by villagers of Cojimar, Cuban port near Habana, carries three two-inch hooks baited with shark fillets or mullet. Each is set at a different depth. Although they are cast adrift, a pennant by day and a lantern at night will re-locate the rigs and enable the fishermen to secure their catches of shark, dolphin, marlin and broadbill swordfish. (Sketch by author)*

Straits of Florida. As a rule two men comprise the crew, and their boat carries ten to fifteen floating fishing rigs of three hooks each. These are baited with fresh shark fillets, or with mullet, just before they are placed in the water, one to four miles offshore.

Hooks At Different Levels

Each two-inch hook is attached by a fifteen-foot wire leader to a one-quarter inch cotton rope, which hangs suspended from a wooden buoy. The hooks of one set hang at different levels in the water, usually at twenty, fifty, and eighty fathoms.

The wooden buoys, spaced forty to fifty feet apart, are joined to each other by a three-quarter inch manila rope, attached at one end to a square wooden float bearing the name of the boat, the number of the set, and a four-foot removable mast carrying a lantern and flag. The lighted floats look very picturesque as they bob about over the darkened sea.

Sets Cost $40 Each

Usually ten sets of three hooks each are placed in a straight line, each set being one to two hundred yards from the next and numbered consecutively one to ten. A set costs approximately forty dollars and, since

each set is an independent unit, the loss of one during a night's fishing does not seriously handicap the fisherman.

After the sets are all placed and the lanterns lit, they are patrolled until dawn. At daybreak the catch of dolphin, marlin, broadbill, and sharks is removed and, if the weather is fair, a set may be rebaited. Some time between eleven o'clock in the morning and three in the afternoon the boats return to Cojimar Harbor with their sets and catch, and, if weather permits, they may leave again the same evening.

For several years these fishermen supplied a small shark products factory in Cojimar with fins, hides, and livers. The fins (pectorals, dorsals, and caudal) were dexterously removed by Raphael and spread out in the sun for a week or more to dry. Once dry, they were bundled and sold to the Orientals for shark fin soup. This delicacy is prepared by removing the skin and dried muscles of the fin and utilizing the cartilaginous radials which form the fin skeleton. When the cartilages are dissected free, they look like spaghetti and in fact are popularly referred to as the

ARGOSY OF THE COJIMAR FISHERMEN. *The open power boats they use are not very large (18 to 24 feet in length), but space is efficiently employed. Note the short masts (amidships) which carry pennants and lanterns. The longer masts (right) support the awning, here wrapped around them. (Photograph from author)*

"spaghettis" by the Cuban fishermen. The cartilages have no taste, but lend body to many flavors of soup which the gifted Chinese chefs prepare.

After the fins have been removed the shark is skinned by making an incision along the mid-line of the back and around each side of the snout and gill clefts. While the shark is lying on its belly, the skin is peeled from the back downward and removed as a single sheet. The hide is then salted, and shipped to the Ocean Leather Company, New Jersey, where the sharply pointed placoid scales are chemically removed, the hide tanned, and an attractive and sturdy leather prepared which has five to eight times the tensile strength of beef leather. Shark leather is used for wallets, belts, cane handles, and to cover the tips of children's shoes.

For years it was the liver of the shark, rich in vitamin A, which made this Cojimar enterprise, and others like it throughout the Caribbean, successful. In the small factory, livers, chopped into chunks the size of one's fist, were boiled down in two large steel vats and the vitamin rich oil extracted. Because labor was relatively cheap and sharks abundant, this enterprise survived for many years after vitamin A was synthesized, but finally in 1958 it became too unprofitable to continue operations and the little factory was closed.

I first learned of this fishery because of my interest in sharks. I have secured from these fishermen, over a period of years, many valuable specimens for study. Vivid still are memories of those afternoons I dissected sharks on the harbor beach while Rafael expertly removed the fins and skin.

But most vivid of all is the memory of that September night I spent with two Cojimar fishermen, Eduardo and José, five miles off shore, while a hurricane (we learned later) was gathering force 150 miles to the east of us.

We left at 11 p.m., checked out at the historic fortress which guards the entrance to Cojimar harbor, and, as we moved offshore, the sea became increasingly more restless. By the time Eduardo and José had placed eight sets, of three hooks each, it was too rough to place any more. All night we patrolled those eight sets, while the sea pitched and tossed our little 22-foot open boat, and the guns of Castro's rebels rumbled faintly in the distant hills.

A "Grande Galano"

At daybreak we began to pull our sets, for by now the waves were very rough and only with difficulty could the ropes be coiled and the gear retrieved from the sea. Our fifth set yielded our only catch, a "grande Galano" or large bull shark, weighing approximately 350 pounds. It must have been recently hooked, for it put up a terrific struggle. Only after ten minutes of clubbing with a wooden "persuader" did its limp body finally come to rest along our starboard side.

The remaining sets were then retrieved and slowly we made our way over the rough sea back to the shelter of Cojimar harbor. Eduardo and José had indeed earned their *tiburón!*

MR. CHARLES F. JOHNSON
Chairman of the Board of Trustees

JOHN A. MANNING
President, I.O.F.

I.O.F. Gets New Pilot

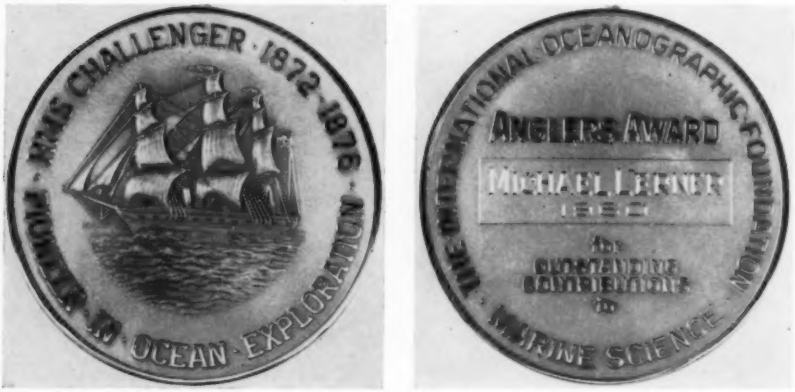
The International Oceanographic Foundation has a new pilot, the third since its founding in 1953. At the annual meeting of the Board of Trustees, held at The Marine Laboratory, University of Miami, November 15, Mr. John A. Manning was elected President. Mr. Charles F. Johnson, who has held this office since 1954, was made Chairman of the Board of Trustees.

Officers re-elected were: Dr. F. G. Walton Smith, Vice President and Executive Secretary; Mr. R. Hardy Matheson, Vice President; Mr. George Collier, Vice President; and Mr. John Mahony, Treasurer.

New members of the Board of Trustees include: Dr. Preston Cloud of the U.S. Geological Survey; Mr. Alfred A. Glassell, Jr., of Houston, Texas; Dr. Melville B. Grosvenor, president of the National Geographic Society; Mr. Eric H. Heckett of Butler, Pa.; Dr. Fritz F. Koczy of the Miami Laboratory; Mrs. Florence May Smith; Dr. Athelstan F. Spilhaus, Dean of Engineering, University of Minnesota; Mr. Leland R. Taylor, vice president of North American Aviation; and Mr. Allyn Vine of the Woods Hole Oceanographic Institution.

The Treasurer's report showed that the Foundation is in sound financial condition and that the paid membership, on October 31, 1960, had increased by 50% over October, 1959.

First Angler's Award Medal



FIRST ANGLER'S AWARD *of the International Oceanographic Foundation "for outstanding contributions to marine science" was presented to Michael Lerner at a special dinner held at Miami Beach, November 16, 1960. Above are the front (left) and back (right) of the gold medal presented by Charles F. Johnson, Chairman of the Board of the Foundation, in behalf of its world-wide membership. Chairman of the occasion was Mr. John Manning, newly elected President. The medal itself was made possible through a donation from Mr. George Collier, Vice President of the Foundation. It was designed by Richard Marra. The Foundation, through this award, hopes to make annual recognition of the support given by anglers to marine science. (Walter R. Courtenay, Jr.)*

Artificial Waves And Model Ships

The third largest ship model towing tank, 1,300 feet long, has been placed in operation by the National Physical Laboratory, a $5,600,000 hydrodynamics station at Feltham, Middlesex, Great Britain. While it is exceeded in length by the U.S. Navy's testing basin at Carderock, Md., near Washington, and by another in Leningrad, the Feltham tank is deeper than either. It will permit ship models under test to undergo several changes in speed during a single run.

Another Feltham tank has a wave-making device to test the sea-keeping qualities of hulls under various conditions.

Science of the Sea in BOOKS

General Reading

THE NATIONAL WATERCRAFT COLLECTION

HOWARD I. CHAPELLE. Smithsonian Institution, Bulletin No. 218. U.S. Government Printing Office, Washington, 1960. 327 pp. Bibliography. Index. 310 illustrations. $3.50 (cloth). If you are interested in the evolution of ships—sail, steam or diesel—this big, well-illustrated volume is a gold mine indeed. Here is assembled all the information, sketches, drawings, and photographs of that storehouse of knowledge of all kinds — the Smithsonian Institution, of Washington, D.C. The author, Howard I. Chapelle, curator of transportation of the Museum of History and Technology, U.S. National Museum, not only has done a splendid job of selecting and arranging the vast amount of material available for the book, but he has given us a text that the layman can understand and enjoy. The book is a *must* for marine archi-

FOR A WORK BOAT, *the Biloxi Fishing Schooner looks rather dashing when under full sail in a brisk wind. A builder's half model of this vessel, the I. Heidenheim, is in the Watercraft Collection of the Smithsonian Institution. Its characteristics are described in "The National Watercraft Collection," reviewed on this page. (Smithsonian Institution)*

tects, designers, and constructors, and a very handy volume to settle those heated little disputes that arise occasionally at yacht clubs, power boat squadron headquarters, and other retreats where those who love ships are wont to gather. E.J.L.

WONDERS OF THE OCEAN ZOO

BORIS ARNOV, JR. AND HELEN MATHER-SMITH MINDLIN. Dodd, Mead & Co., New York. 1957. 96 pages, numerous illustrations. $2.75.

This book is written for children in the grade schools and describes some of the more interesting and unusual animals of the sea. It is factually accurate and presented in an interesting way. The illustrations are not as good as might be hoped but, in general, the book is to be recommended. C.P.I.

CREATURES OF THE SEA

CAPTAIN WILLIAM B. GRAY. Wilfred Funk, Inc., New York. 1960. 209 pages, numerous illustrations. $3.95.

It was inevitable that this book would be written, although how his publisher was able to interrupt Captain Gray's busy life long enough to get him to record some of his incredible fish-collecting adventures must remain an editorial secret.

Basically, this is the thrilling life history of the man who might be called the "Frank Buck of the Sea." Captain Gray has "brought back alive" many thousands of odd and husky sea creatures, ranging from sharks, sea cows and porpoises, to such rare specimens as threadfish, manta rays, and poison-bearing scorpionfish.

As Director of Collections and Exhibitions at the Miami Seaquarium, Captain Gray has stocked its tanks with a wealth of glamorous, playful, grotesque and even terrifying marine life—of interest and value not only to the ordinary visitor, but also to scientists engaged in biological and medical research. While "Creatures of the Sea" is nontechnical, it is crowded with absorbing information and photographs, rewarding to both the landlubber and mariner.

Technical Reading

THE SEA OFF SOUTHERN CALIFORNIA

K. O. EMORY. John Wiley & Sons, Inc., New York. 1960. 366 pp. Illustrated. Indices. Bibliography. $12.50.

This is an excellent summary of the results of numerous investigations which have been carried out off the coast of Southern California. It covers the physiography, lithology, structure, and sediments of the coastline and seafloor, and the physical and biological oceanography of the waters. It also includes a discussion of pollution and radioactive waste disposal.

The book should be of considerable value as a reference book, not only to students, but also to engineers and geologists. F.G.W.S.

PHYSICS AND GEOLOGY

J. A. JACOBS, R. D. RUSSELL, J. TUZO WILSON. McGraw-Hill Book Company, Inc., New York, 1959. 424 pages. $9.75.

A wide gap in the English scientific literature has now been filled by a book on geophysics which deals with the total aspect of the physics of the earth and not only with geophysical methods of oil exploration.

Written by three physicists, specialists in geology, mathematics and chemistry, the book covers all scientific aspects of the processes and forces contributing to the structure and final shape of the earth. The intensified research during the geophysical year has contributed considerably to broaden the aspects and has given the backbone to the excellent exposition

of the known physical and chemical processes affecting the internal structure of the earth. An oceanographer realizes with satisfaction that geophysical research of the ocean has contributed the most important part in remodeling many of the old ideas about the structure of the earth.

F.F.K.

MARINE BORING AND FOULING ORGANISMS

D. L. RAY, Ed., Seattle, Univ. of Washington Press. 1959. 536 pages. $8.50.

The control of boring and fouling organisms is of vital importance to those who are concerned with any type of marine structure. An understanding of the biology of the organisms concerned is basic in the development of improved methods of control. This book reports the symposium held in Friday Harbor in 1957 and assembles an extremely valuable series of articles and references. It covers the boring crustacea and molluscs, but only the barnacles among fouling organisms. There is a series of papers on the enzymes which break down cellulose in wood and fibre, and their occurrence in molluscs, crustacea, fungi and bacteria. Finally there is a section on certain chemical treatments used in wood preservation. The literature cited in the various articles would in itself make them a most valuable reference work.

H. B. M.

ECOLOGY AND DISTRIBUTION OF RECENT FORAMINIFERA

FRED B. PHLEGER. The Johns Hopkins Press, Baltimore. 1960. 297 pages. $7.50.

This book summarizes most of the work done in recent years in the field of foraminiferal ecology, providing a volume all the more welcome because of the great importance of foraminifera in pure and applied geology. The bulk of the book (174 pages) is dedicated to the areal and depth distribution of different species of benthonic foraminifera. The author pointedly stresses the dubious validity of depth ranges based on thanatocoenoses and rightly states that reliable depth ranges can be obtained only from biocoenoses. The problem of foraminiferal shells or assemblages displaced downslope by various geologic agents is discussed at some length.

Much information is summarized in tables and drawings. Some forty pages are dedicated to a discussion of the areal and depth distribution of planktonic foraminifera. Correlations among deep-sea cores by means of the relative abundance of low, middle and high latitude faunas are exemplified in three figures. Other methods of correlations are briefly mentioned. One page discusses the geological ranges of extant species. In so far as this topic was introduced, a far more detailed discussion would have been advisable.

Field and laboratory methods and techniques are treated in some detail. A few (rather perfunctory) pages are dedicated to physical and chemical oceanography and to a discussion of the major marine environments. The restraint of the author is, however, justifiable because these subjects are treated in other textbooks.

The author has done pioneering work in almost all of the topics discussed in the book. Therefore, he is compelled to talk a lot about himself. It is gratifying to notice that he is as critical toward his own work as he is toward that of his colleagues. Some omissions from the list of references: Buchner 1940, Dos Santos Pinto 1950, Emiliani 1955, Flint 1957, Freydank 1955, Norvang 1945, Saunders 1958, Silvestri 1950. C. E.

About the Authors

FRITZ F. KOCZY

Dr. Koczy (pronounced "Coach-ee") came to The Marine Laboratory of the University of Miami in 1957, where he is chairman of the Division of Physical Sciences, after nearly twenty years' experience as an oceanographer and physicist in Sweden. In addition to active research with the Swedish deep sea expedition, Dr. Koczy served on the Board of Swedish Fisheries and with the Oceanographic Institute of Göteborg. Born in Vienna, Austria, he received his Ph.D. at the University of Vienna in 1939.

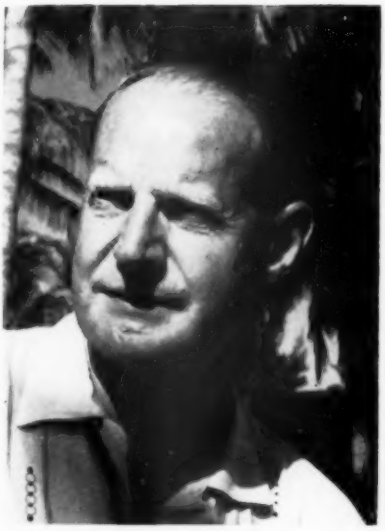
He is a member of the Committee on Oceanography of the National Academy of Sciences and the National Research Council, and also of the working group in radioactivity of the Special Committee on Oceanic Research. His hobbies include photography, piano playing and gardening.

M. D. BELLOMY

Miss Bellomy is both a medical and science writer, in addition to being editor of the *Aquagest*, the official publication of the Miami Aquarium Society, and the technical editor of *Cancer Cytology*, the official journal of the Cancer Cytology Foundation of America, Inc.

An ardent fisherwoman, she also likes to collect marine tropicals and the young of some game fishes, maintaining them in home aquaria. Among her prizes is a schoolmaster snapper, netted in 1957, when it was about half an inch long. It now measures 6½ inches. She also has four or five live beau gregories.

In addition to articles written for the *Aquarium Journal*, *Aquarium Magazine*, *All Pets*, *Tropical Fish Hobbyist*, and *Natural History*, Miss Bellomy is working on two books, one a text on maintaining marine tropicals at home, and the other a general volume on the sea and sea life.



PERRY W. GILBERT

A professor of zoology at Cornell University, far from the sea, Dr. Gilbert frankly confesses "my principal research interest for the past several years has been the biology of sharks, skates and rays. Studies of the sense organs and reproductive patterns of these fishes will undoubtedly occupy all of my research time for the next fifteen years." It was in pursuit of this interest that Dr. Gilbert came upon the unusual method of long-line fishing used by the fishermen of Cojimar, Cuba, scene of Hemingway's *The Old Man and the Sea.* That he is well qualified to write in this field is indicated by his experience as a Carnegie Fellow (Embryology), and later as a Guggenheim Fellow at the Mount Desert Island Biological Laboratory, Maine. Dr. Perry is also the chairman of the A.I.B.S. Shark Research Panel, and a member of the panel on Biological and Medical Sciences, Polar Research Committee. His research work includes aquatic birds as well as fishes.

GARDNER SOULE

Gardner Soule was officer-in-charge of the *Training Bulletin,* a monthly magazine of the U.S. Navy during World War II. He is a free-lance writer, and has contributed articles on scientific, mechanical, or nautical subjects to *Popular Science, National Geographic, Illustrated London News,* and many trade publications. He began his writing career as a newspaperman with the Associated Press.

Puerto Rican Tuna Cannery

Prospects of a tuna canning industry on the Atlantic side of the continent, which might some day compare with that along Pacific waters, were enhanced recently by the completion of the second tuna cannery in Puerto Rico. This cannery, by the Star Kist Company, is in addition to the Van Camp tuna cannery, established at Ponce a few years ago.

Congratulations

MEMBERS are to be congratulated that their numbers have more than doubled every twelve months in the few years since the Foundation began its work. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Turkey, Denmark, Sweden and Norway as well as a few from the Pacific Islands, the West Indies and Russia.

CONTINUED IMPROVEMENT will be possible with growth of active membership. It will be seen in better service, with more articles in the magazine of high interest and authenticity and, eventually, a monthly issue in full color.

IN ADDITION TO PUBLISHING *Sea Frontiers* and *Sea Secrets,* the Foundation provides active support for scientific research and education. The ocean is our last frontier and its exploration still under way.

THE EDITOR will be glad to consider for publication articles and illustrations covering explorations, discoveries or advances in our knowledge of the marine sciences or describing the activities of oceanographic laboratories or expeditions in any part of the world.

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Members are those who support the Foundation through personal efforts in the advancement of our objectives or by annual donations in the following categories:

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We urge you to consider membership. This will provide support to vital research and scholarships as well as defray the cost of printing and mailing of your *Sea Frontiers* and *Sea Secrets.*

According to a ruling of the U.S. Treasury Department, donations made to the Foundation are deductible in computing taxable income as provided for in the 1954 code.

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"To encourage the extension of human knowledge by scientific study and exploration of the oceans in all their aspects, including the study of game fishes, food fishes, ocean currents, the geology, chemistry, and physics of the sea and the sea floor."

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